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VH-830

TM-2

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Antenna PRODUCTS

101 S.E. 25th Ave., Mineral Wells, TX 76067

1500-0267-201

Technical Manual

for

VH-830 TM/2

ANTENNA

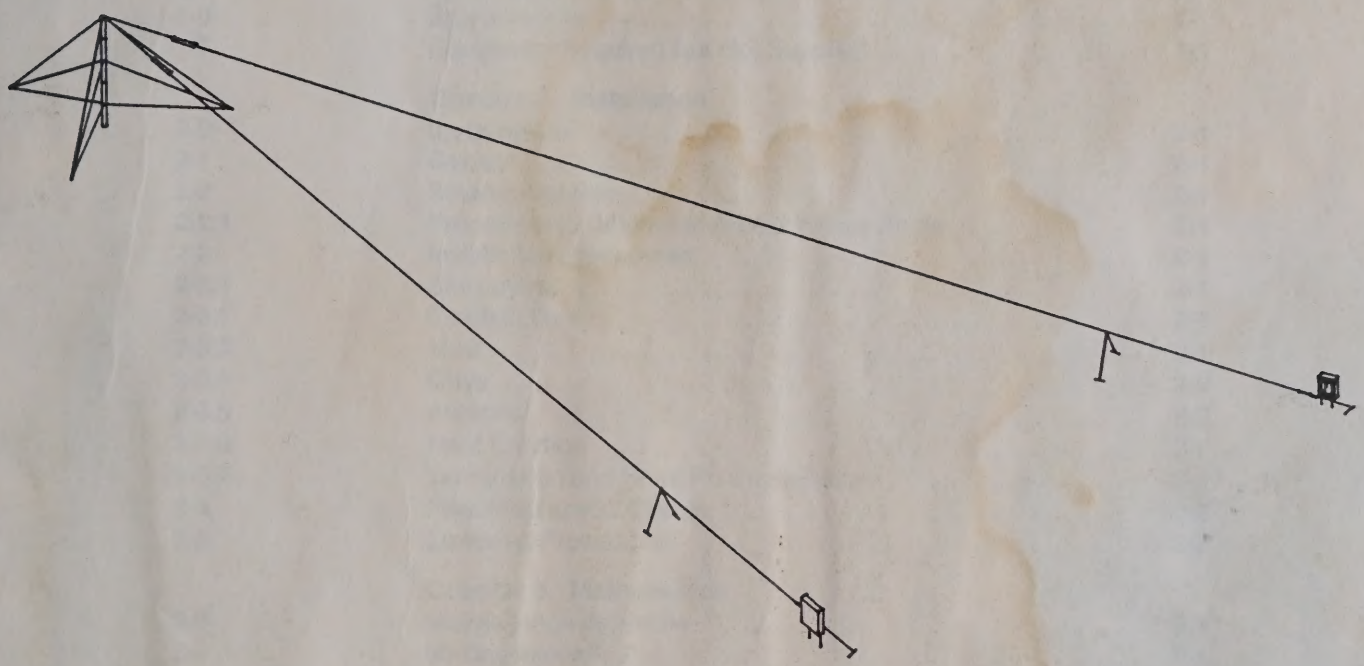
101 S.E. Ave., Mineral Wells, TX 76067

15 MARCH 1991

USER HANDBOOK

VH-830 TM/2 TRANSPORTABLE HF ANTENNA

Installation and Maintenance Instructions



ANTENNA PRODUCTS

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SAFETY PRECAUTIONS

The following are general safety precautions that are not related to any specific procedures and therefore do not appear elsewhere in this publication. These are recommended precautions that personnel must understand and apply during many phases of operation and maintenance.

WARNING

THIS EQUIPMENT CAN ATTRACT ATMOSPHERIC ELECTRICAL DISCHARGES TO GROUND. DO NOT ATTEMPT TO ASSEMBLE OR ERECT THE ANTENNA DURING ELECTRICAL DISTURBANCES.

WARNING

FAILURE TO PROVIDED ADEQUATE ANCHOR HOLDING CAPABILITIES WILL RESULT IN COSTLY DAMAGE TO EQUIPMENT AND POSSIBLE SERIOUS INJURY TO PERSONNEL.

WARNING

ALL TOOLS AND EQUIPMENT WILL BE MAINTAINED IN A SAFE CONDITION WITH EMPHASIS ON LIFTING AND SAFETY GEAR.

WARNING

PROTECTIVE EYE COVERS SHOULD BE WORN WHILE DRIVING THE ANCHORS. FLYING CHIPS FROM THE HAMMER OR DRIVING ROD HEAD COULD CAUSE SERIOUS EYE INJURY.

INTRODUCTION

This publication was prepared by Antenna Products Corporation, 101 S.E. 25th Ave., Mineral Wells, Texas, 76067. The equipment described consists of a transportable hf antenna designed for medium to long range sky wave circuits. The antenna is intended for use in the 8 to 30 MHz frequency band. Operation is extended down to 2 MHz with reduced performance. The antenna is utilized in tactical situations where quick erection and medium to long range circuits are required. The Antenna Products type designation for this antenna group is VH-830 TM/2.

This manual contains general description, technical information, and assembly/disassembly procedures for the antenna supplied. These procedures are the basic requirements for satisfactory operation. The information provided in this manual is divided into five chapters:

Chapter 1 covers general information, specifically, the description and purpose of the equipment.

Chapter 2 provides information relative to unloading, unpacking, receiving data, material handling, and instructions for assembly of support structure. Also covered is assembling and installing the antenna group.

Chapter 3 covers theory of operation with a view to maintenance and trouble analysis.

Chapter 4 covers maintenance information for field and base repairs on lightweight telescopic masts.

Chapter 5 covers the Illustrated Parts Breakdown, including indexes for locating replaceable parts.

Notes, Cautions and Warnings shall be used in the service instructions as follows:

a. Notes contain operating procedures, conditions, etc., which should be highlighted.

b. Cautions contain operating procedures, practices, conditions, etc., which, if not strictly observed, will result in damage to or destruction of equipment.

c. Warnings contain operating procedures, practices, etc., which, if not strictly observed, will result in injury to personnel or loss of life.

CHAPTER 1. GENERAL INFORMATION

1-0 GENERAL INFORMATION.

1-1 **PURPOSE.** The purpose of this manual is to acquaint the user with the method of erection and maintenance of the VH-830 TM/2 Sloping Vee Antenna.

1-2 **GUARANTEE.** (1) Antenna Products Corp. guarantees each item against defects in material and workmanship. This guarantee extends for a period of one year from the date of installation or use unless otherwise specified, provided that this period shall not exceed two years from the date of delivery. (2) Upon notice in writing, Antenna Products Corp. will promptly repair or replace all defective or damaged items. Antenna Products Corp. may elect to have any replaced item returned to its plant at its expense. (3) This guarantee shall exclude expendable items and material normally consumed in operation unless excepted items fail as a result of improper installation or application by Antenna Products Corp., in which case the guarantee shall be equally applicable to these items. (4) Antenna Products Corp. is not liable for any incidental or consequential damage to any customer or representative there of resulting from interconnects, installation, and erection, or use, whether proper or improper. (5) Freight damages are not covered under equipment guarantee. Such claims must be presented by the customer to the transportation carrier regardless of whether the shipment is freight prepaid or freight collect. Under no circumstances is material to be returned to Antenna Products Corp. without Antenna Products Corp's written consent.

1-3 PURPOSE AND DESCRIPTION.

1-3.1 Purpose of Equipment. The VH-830 TM/2 is a directional, transportable hf antenna designed for medium to long range sky wave circuits. The antenna is intended for use in the 8 to 30 MHz frequency band. Operation is extended down to 2 MHz with reduced performance. The antenna system is utilized in tactical situations where quick erection and medium to long range circuits are required. The antenna is horizontally polarized- ed for efficient performance over all types of soil. It consists of a 50-foot telescoping mast, balun, elements, and terminations. The elements are fed at the top of the mast by means of a 50/800 ohm balun that will handle up to 10 kW of power and is supplied with type "HN" rf connectors and a 50-foot length of RG-393/U coaxial cable. The ends of the elements are terminated in a resistive load to ground. The input impedance of the antenna is 50 ohms and the VSWR is 2:1 maximum.

1-3.2 Description of Equipment.

1-3.2.1 *Antenna Curtain.* The antenna curtain consists of two element assemblies made of 3/32 diameter nylon coated galvanized wire approximately 500 feet long.

1.3.2.2 *Telescoping Mast.* The key to the transportable design is the 50-foot lightweight, telescopic mast for ease of erection. The mast is precision-engineered and designed to meet the quick erect and ease of handling requirements for a transportable system. In practice, the mast is exceedingly simple to erect and retract. Air-damped retraction is used to ensure smooth, safe operation of the telescoping tubes.

The mast is manufactured from high tensile aluminum alloy, they are then anodized and dyed olive drab. Each section is positively locked in its full or partially extended position by a specially designed friction clamp. This clamp, also anodized, is a particular feature which provides a positive self-aligning clamping force actuated by a lever, forming an over-center locking arrangement. The rate of fall during retraction is controlled by a pneumatic damping system which ensures the safety of the operator and the equipment attached to the mast. The telescoping mast is normally supplied complete with an accessory kit comprised of all items needed for field deployment.

1-3.2.3 *Balun (SM-207).* The antenna is fed with a 50/800 ohm balun. A 50-foot length of RG-393/U coaxial cable connects between the balun at the top of the mast and ground. The input connector is a female type "HN" rf connector installed on the coaxial cable.

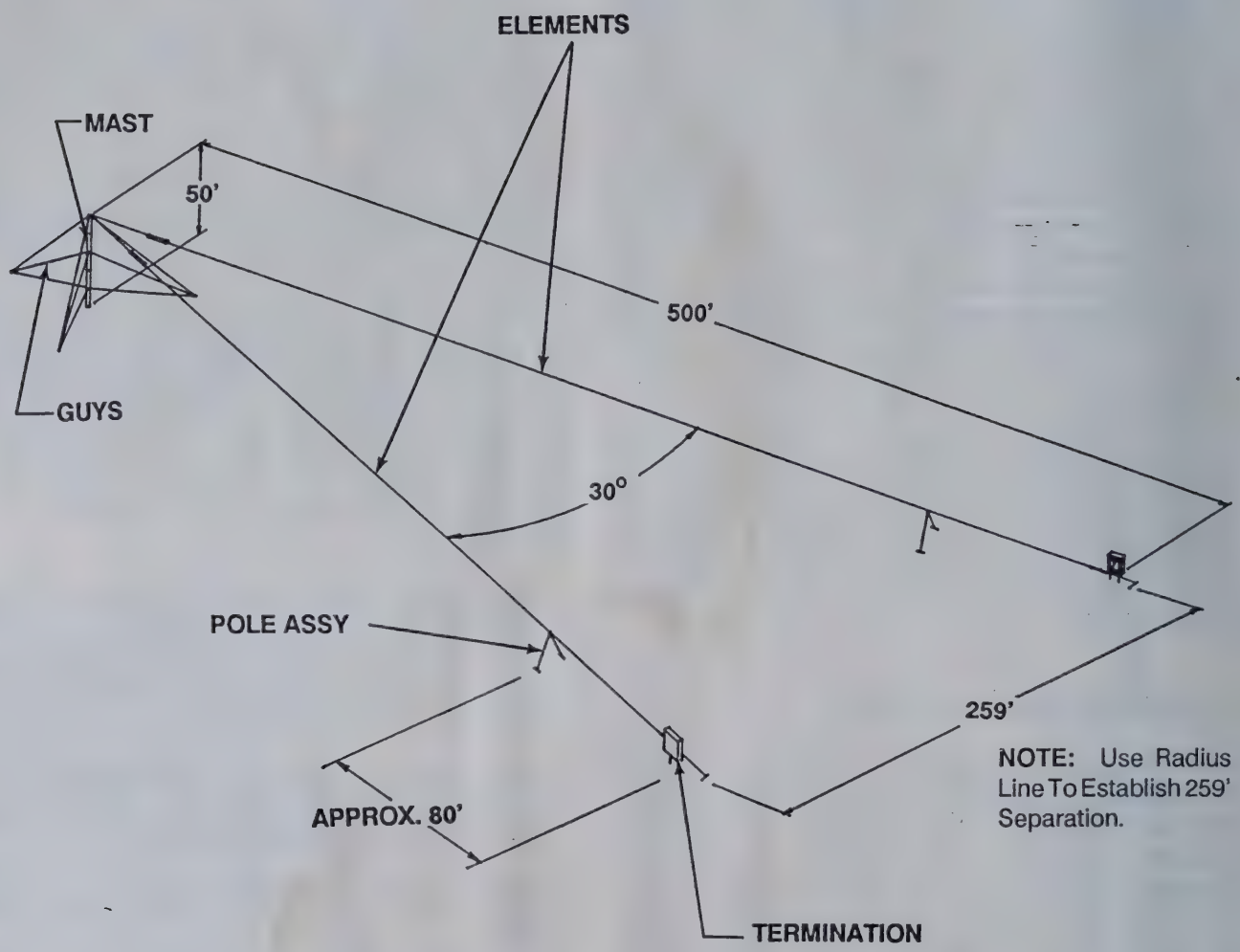
1-3.2.4 *Termination (RX-15).* The 450 ohm heavy duty terminations consist of six rf power resistors mounted within aluminum protective enclosures.

1-4 **EQUIPMENT SUPPLIED.** Table 1-1 lists material supplied.

1-5 **LEADING PARTICULARS.** Table 1-2 lists power requirements, physical dimensions and weights.

1-6 **SPECIFICATIONS.** Table 1-3 lists mechanical and electrical characteristics of the antenna.

1-7 **EQUIPMENT REQUIRED BUT NOT SUPPLIED.** The VH-830 TM/2 antenna is completely equipped. the only equipment required to make them operable is suitable transmitting or receiving equipment.



Complete Illustration of Equipment

Figure 1-1. VH-830 TM/2 Sloping Vee Antenna

Table 1-1. Equipment Supplied

MFR. PART NO.	MFR. NOMENCLATURE	DESCRIPTION
1500-0267-201	System Items,	VH-830 TM/2 Antenna C/O:
1000-1007-201	Mast Items:	Consists of 15-meter pneumatic telescopic mast w/case.
1000-1176-201	Antenna Items:	Consists of two element assemblies, one radius line, four termination posts and one 50-ft coax assembly.
1000-1431-401	Termination:	Consists of two heavy duty (RX-15) 2 kW, 450 ohm termination assemblies.
1000-1177-401	Balun:	Consists of one 10 kW, (SM-207) 50/800 ohm balun.
1000-1279-201	Accessory Items:	Consists of step ladder, base plate, ten mast plate pins, radius line, tool kit, hammer, foot pump, six velcro straps and two pole assemlies. Also, included is all required guys and stakes.
4200-0030-002	Transit Case: (Optional)	Consists of unpacked transit case.
4200-0030-003	Transit Case: (Optional)	Consists of unpacked transit case.

Table 1-2. Leading Particulars

Electrical	
Power	10 Kw Avg (degraded below 8 MHz)
Input Connector	Type "HN" Female (50 ohms)
Dimensions Erected	
Height (H)	50 feet (15m)
Width (W)	259 feet (78.9m)
Length (L)	500 feet (152.4m)
Weight	
Transit Case No. 1:	15.75" W x 14.25" H x 113.5" L
(Unpacked)	84 lbs
(Packed)	265 lbs
Transit Case No. 2:	27.75" W x 14.25" H x 75" L
(Unpacked)	84 lbs
(Packed)	240 lbs
Balun SM-207	22 lbs
Termination RX-15	27 lbs
Mast Height and Weight	
Extended Height	49.2 ft (15 m)
Retracted Height	8.85 ft (2.7 m)
Weight	103.6 lbs (47 Kg)
Sections	7

Table 1-3. Specifications

Electrical	
Frequency Range	8-30 MHz 2-30 MHz With Reduced Performance
Polarization	Horizontal
Power Gain	4 to 8 dBi
Radiation Characteristics	See Patterns, Chapter 4
VSWR (Maximum)	2.0:1
Power Handling Capability	10 kW Avg/20 kW PEP (degradated below 8 MHz)
Input Connector	Type "HN" Female
Input Impedance	50 ohms
Mechanical	
Wind Loading	100 mph (87 knots)
Erection Time	2 men - 60 minutes
Type of Service	Continuous and Unattended

CHAPTER 2. INSTALLATION

2-0 **INTRODUCTION.** The VH-830 TM/2 Sloping Vee Antenna is utilized in tactical situations where quick erection and medium to long range circuits are required. The antenna is horizontally polarized for efficient performance over all types of soil and will handle up to 10 kW of power. The antenna system is easily erected by a two-man crew in sixty (60) minutes. The key to the transportable design is the lightweight, 50-foot telescoping mast. The mast is precision engineered and uses air-damped retraction to ensure smooth, safe operation of the telescoping tubes. The elements are fed with a 50/800 ohm balun that is located at the top of mast. The ends of the elements are terminated in a resistive load to ground. The input impedance of the antenna is 50 ohms and VSWR is 2.0:1 maximum.

2-1 **GENERAL.** The antenna installation is a relatively straightforward process. It is a lightweight, rugged design stowed in a relatively small volume. Prior to installing the antenna, it is suggested that each erection crew member read the entire installation section in order to become familiar with procedure, component parts and their function. The quick erect, tactical antenna does not require crating or special packing for deployment. As the antenna system is lightweight, no special hoisting equipment is needed. The physical dimensions of the VH-830 are listed in Table 1-2. Inventory both transit cases (if supplied) and ensure that it contains all listed in Figures 2-2 and 2-3. The antenna and components need no special environmental protection.

WARNING

FAILURE TO OBSERVE THE FOLLOWING PROCEDURE COULD RESULT IN POSSIBLE SERIOUS INJURY TO PERSONNEL AND COSTLY DAMAGE TO EQUIPMENT.

2-2 **SELECTION OF SITE.** Special attention must be paid to both electrical and mechanical characteristics of the site to ensure optimum performance of the antenna.

2-2.1 Procedure to Determine Antenna Apex Angle. The apex angle can be varied to optimize performance specific as follows:

NOTE

30° ANGLE IS DETERMINED BY RADIUS LINE SUPPLIED ALL OTHER ANGLES TO BE DETERMINED BY THE USE OF A 100-FT (MIN) TAPE MEASURE.

a. Select desired frequency of propagation.

b. Select optimum angle to be used from Figure 2-4.

c. From Table 2-1 select (x) and (d) dimensions for optimum angle.

d. Layout site (using x and d dimensions) as shown in Figure 2-5.

e. Install antenna per instructions.

2-3 **INSTALLATION PROCEDURES.** To erect the antenna properly, the following group of procedures should be preformed in the order presented.

2-3.1 Site Layout.

a. Select a site as level as possible and place mast and accessories near the center.

b. Place base plate (Item 10) on the ground and secure with pins (Item 12) as shown in Figure 2-6.

c. Unwind the radius line (Item 11). Loop it over the center hole in the base plate. Fully extend the radius line in the opposite direction to the direction of propagation. The guy that attaches to this anchor will oppose the pull of the elements. Then drive a guy stake (Item 13) into the ground (See Figure 2-6) using the wire frame as a guide. The stake should lean away from the mast at approximately 30° to the vertical and the eye must face toward the mast. Repeat this procedure to position the remaining two guy stakes 120° apart. Rewind the radius line and place it in the transit case.

2-3.2 Erection Guys.

a. Clip the lower guys onto the eyes of the stakes as shown in Figure 2-8, ensuring that the adjusters are at the end closest to the mast.

2-3.3 Mast.

a. Remove the mast from the transit case.

b. Place the mast base spigot in the central hole in the base plate and bring the mast to the vertical position.

c. Release the straps and position the step assembly on the No. 1 mast section (see Figure 2-6, Arrangement of Step Ladder).

d. Clip the lower guys to the mast as shown in Figure

2-7 and adjust them as required to position the mast vertically. This can be checked by the level built into the step.

e. The lower guys must be tight as they take the entire load of the mast during erection.

2-3.4 Guys.

a. Unwind the middle guys (identified by square tags) and clip the adjuster ends to the guy stakes and the other end to the mast.

b. Repeat Step "a" with the upper guys (identified by square tags). The steel cable guy must be attached to the back guy anchor.

2-3.5 Antenna.

a. Install the balun on top of the mast as shown in Figure 2-7. Secure the balun in this position with the clamp screw. Attach the coaxial cable to the type "HN" connector on the balun.

b. Clip the elements to the balun and connect pigtails to balun as shown in Figure 2-7. Fully unwind the elements approximately as shown in Figure 2-1.

c. Pin down the step assembly to the ground to prevent further rotation. See Figure 2-6.

2-3.6 Mast Erection.

a. Ensure that all guys and elements are correctly attached and free from tangles. Stand on the step assembly to carry out the following operations.

b. Ensure that all clamp levers are in the closed position. See Figure 2-7.

c. Release the top section clamp by pulling the lever to open position. See Figure 2-7.

d. Raise the top section until it is fully extended by filling the mast with air using the foot pump or an air compressor. Plug the supply into the bayonet socket in the mast base. The maximum pressure allowed is 25 psi, at which point the mast safety valve should operate to protect the mast. The air supply should be regulated at 20 psi.

e. Clamp the section by moving the lever to the closed position when the section is fully extended.

f. Repeat for all other sections until the mast is fully extended, securing the coax cable to the mast at approximately 5-ft intervals with straps (Item 16).

g. The middle and upper guys should be adjusted so that the mast is as straight and vertical as possible and tensioned very tightly to remove any slackness and rope stretch.

h. Remove air supply.

2-3.7 Termination and Front Pole Installation.

a. Pull one element tight and install the first termination post (Item 21). Attach element to stake. Locate the first two termination posts as shown in Figure 2-9. Locate and install the second guy stake using the full length of the radius line (Item 20) to establish separation. Then locate and install the second two termination posts as shown in Figure 2-9.

b. Install the pole assembly as shown in Figure 2-10. The insulator at the top of the pole assembly is slotted to receive the element cable. Push the insulator up onto the element and then rotate the assembly until it is 90° to the element cable. Move the pole assembly until the proper height is achieved then stake in place as shown in Figure 2-9.

NOTE

THE POLE ASSEMBLY IS APPROXIMATELY 80 FEET FROM TERMINATION POST.

c. Tension the elements by means of the adjusters in the element tails.

d. Mount terminations (Item 23) to termination posts by means of the clamps on the backs of the terminations as shown in Figure 2-9.

e. Secure the element pigtail as shown in Figure 2-9.

f. Adjust mast, guy tensioners as required to straighten mast again.

2-4 FINAL MECHANICAL CHECK. After completing the installation, carefully inspect the overall antenna. All the anchors must be checked periodically for loosening or pullout. Special attention should be given this inspection during strong wind, storms or rain. After checking all connections for tightness prior to application of power, the antenna is ready for performance measurements.

Refer to Chapter 4, (para. 4-3) Antenna VSWR Performance Check.

This completes the installation of the VH-830 TM/2 Sloping Vee Antenna.

2-5 LOWERING PROCEDURES.

NOTE

THE MAST IS AIR DAMPED TO CONTROL THE RATE OF DESCENT OF THE SECTIONS.

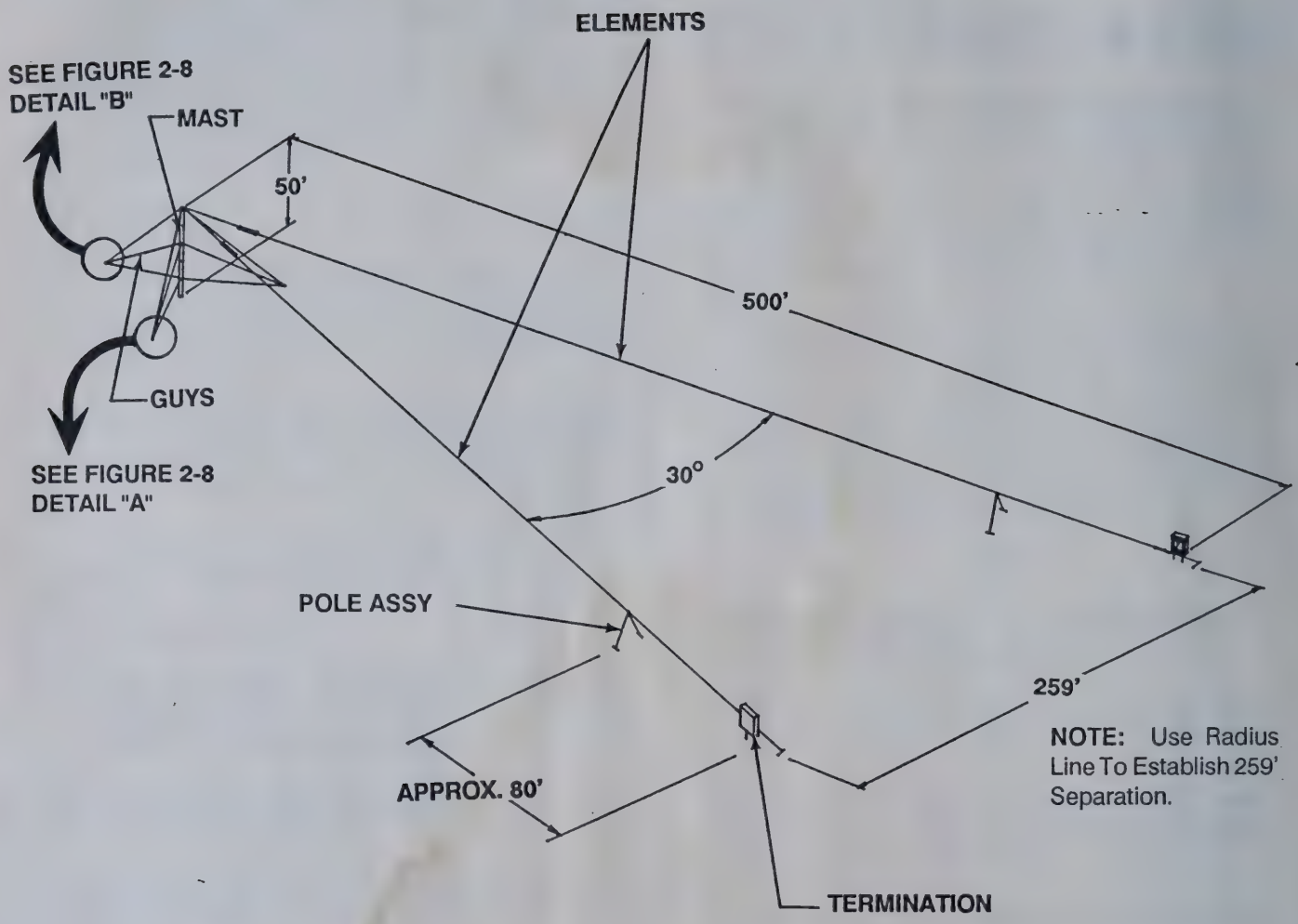
a. Disconnect element tails and remove stakes and terminations.

b. Remove the air supply and fit the exhaust valve tool in its place on the inlet valve.

c. Release the lower clamp and allow the section to descend. Close the clamp when the section is completely down.

d. Repeat with all the remaining sections.

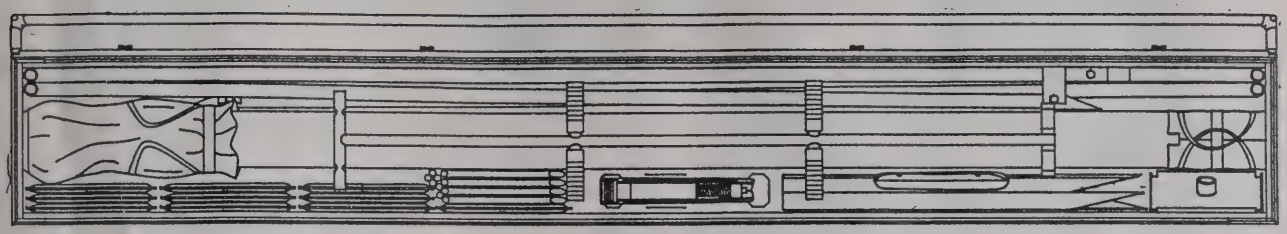
e. The elements, guys, and radius line should be rewound on the winder boards provided and neatly stowed with the other components in their respective transit case (if supplied). Refer to Figures 2-2 and 2-3.



(Sloping Vee Configuration)

400 to 1000 Miles, Directional

Figure 2-1. VH-830 TM/2 Antenna

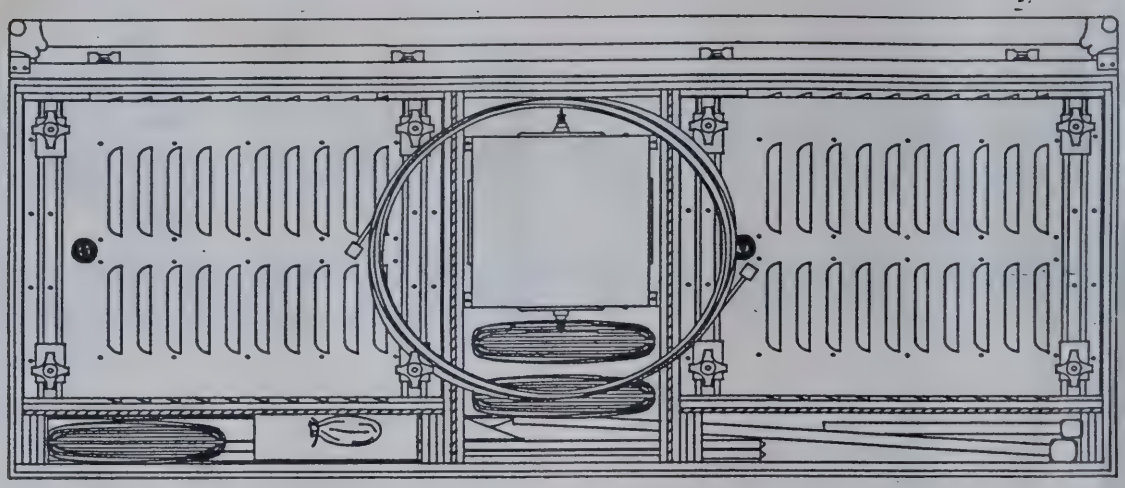


Transit Case No. 1, Antenna Compontents

Part Number	Description	Qty
4200-0030-003	Transit Case	1*
1000-1007-201	Mast, 15m, PM457	1
8902-0020-001	Tool Kit	1
0003-0428-201	Pole Assembly	2
0003-0548-301	Ladder Assembly	1
0003-0507-301	Base Plate Assembly	1
0003-0508-201	Pin, Mast Plate	10
0002-8847-303	Stake, Guy	2
0003-2443-301	Stake, Back Guy	1
0003-0420-201	Line, Radius	1
0003-0419-301	Top Guy Assembly	2
0003-0419-302	Middle Guy Assembly	3
0003-0419-303	Lower Guy Assembly	3
0003-0613-201	Top Back Guy Assembly	1
2450-2248-001	Foot Pump	1

*OPTIONAL

Figure 2-2. Transit Case No. 1 (Packed)



Transit Case No. 2, Antenna Compontents

Part Number	Description	Qty
4200-0030-002	Transit Case	1*
1000-1431-401	Termination Assy	2
1000-1177-401	Balun Assy	1
0002-8847-303	Stake, Guy	2
0003-2444-303	Element Assy	1
0003-0439-201	Radius Line, Element Assy	1
0003-4195-201	Post, Termination	2
0003-0544-201	Coax Assy	1
0003-0555-201	Coax Strap	6
2450-2247-001	Hammer, Hand	1
2450-2251-005	Hammer, Sledge	1
	Technical Manual	1

***OPTIONAL**

Figure 2-3. Transit Case No. 2 (Packed)

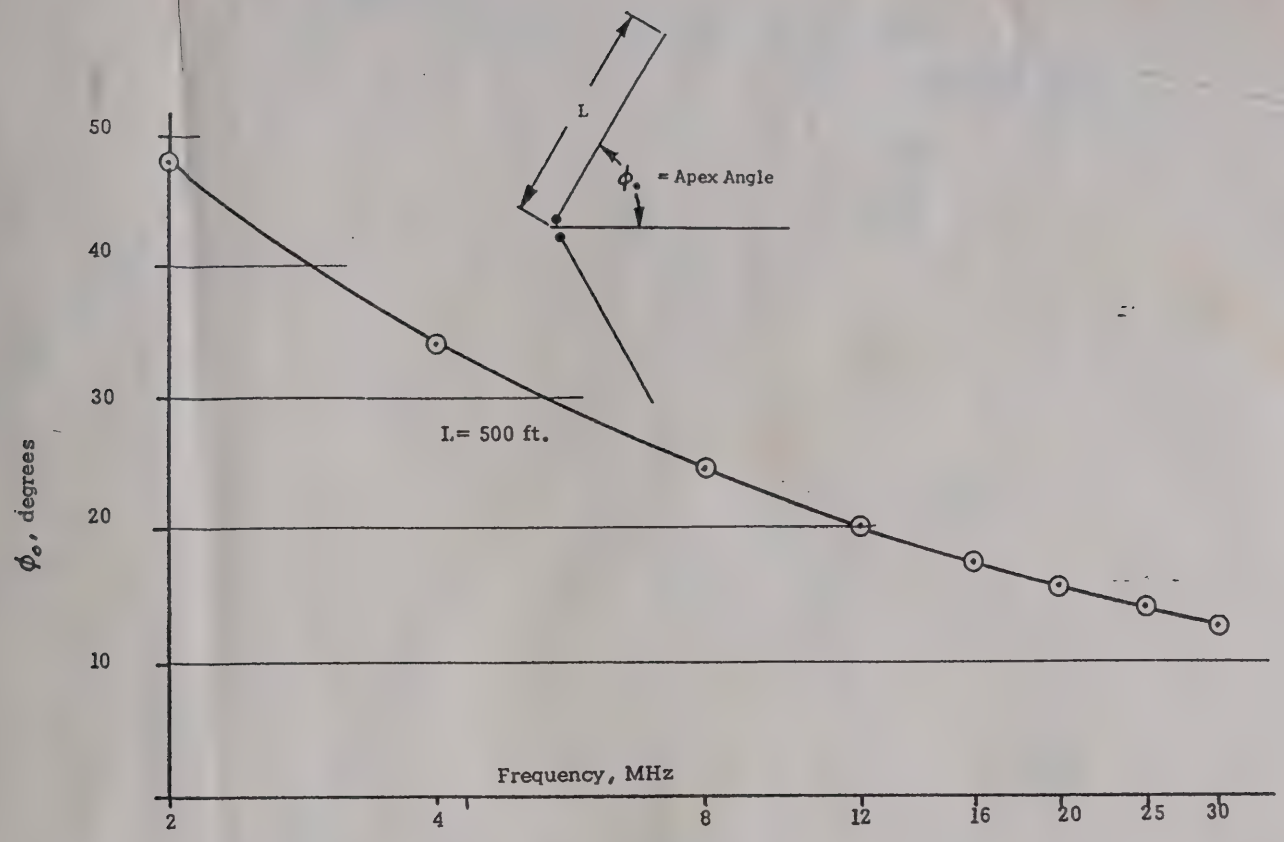


Table 2-1. Antenna Apex Angle

500-ft Leg

0°	x	d
15°	129'-5"	489'-7"
20°	171'-0"	467'-4"
25°	211'-4"	450'-7"
30°	250'-0"	430'-4"
35°	286'-9"	406'-8"
40°	321'-5"	380'-0"
45°	353'-6"	350'-3"
50°	383'-0"	317'-9"

Figure 2-4. Optimum Apex Angle of Sloping Vee Frequency

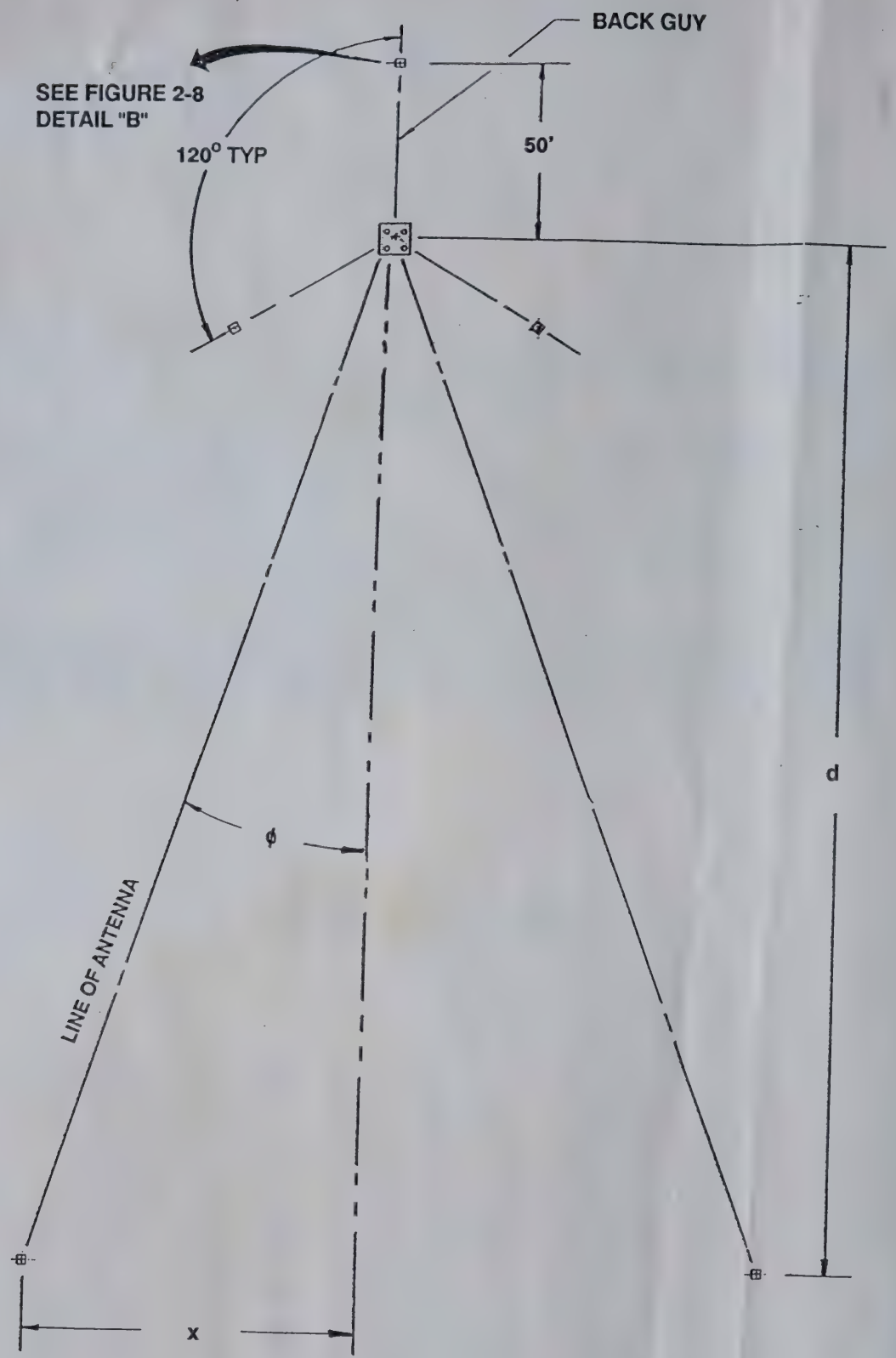
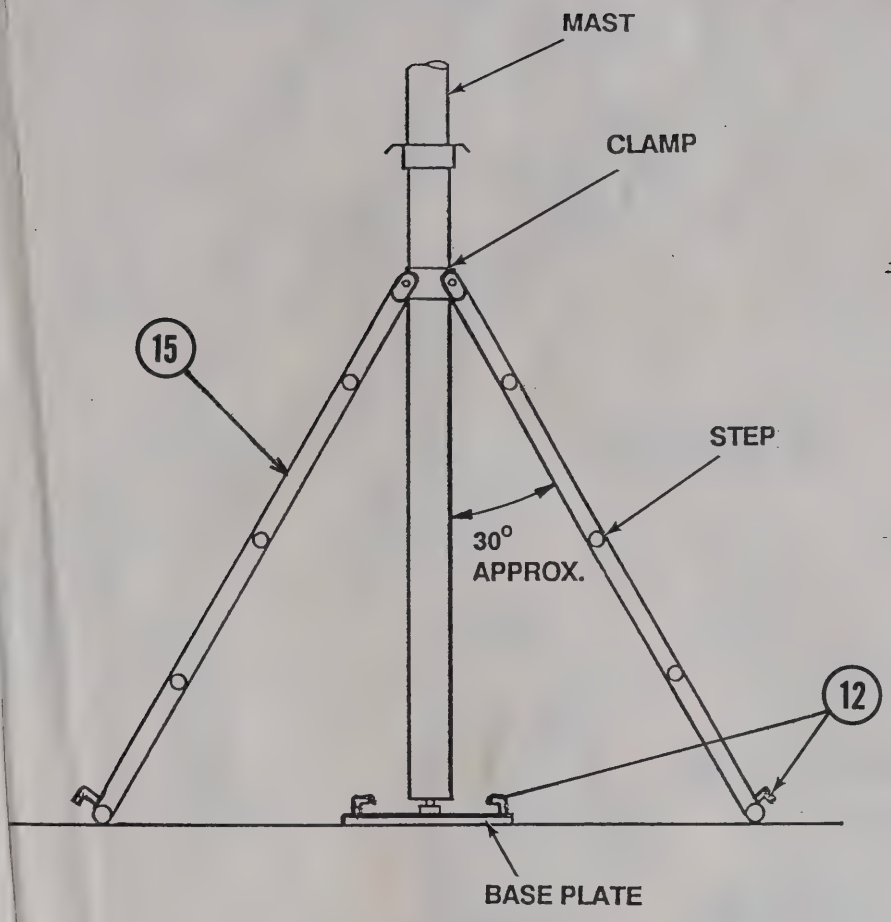


Figure 2-5. Site Layout



Arrangement of Step Ladder

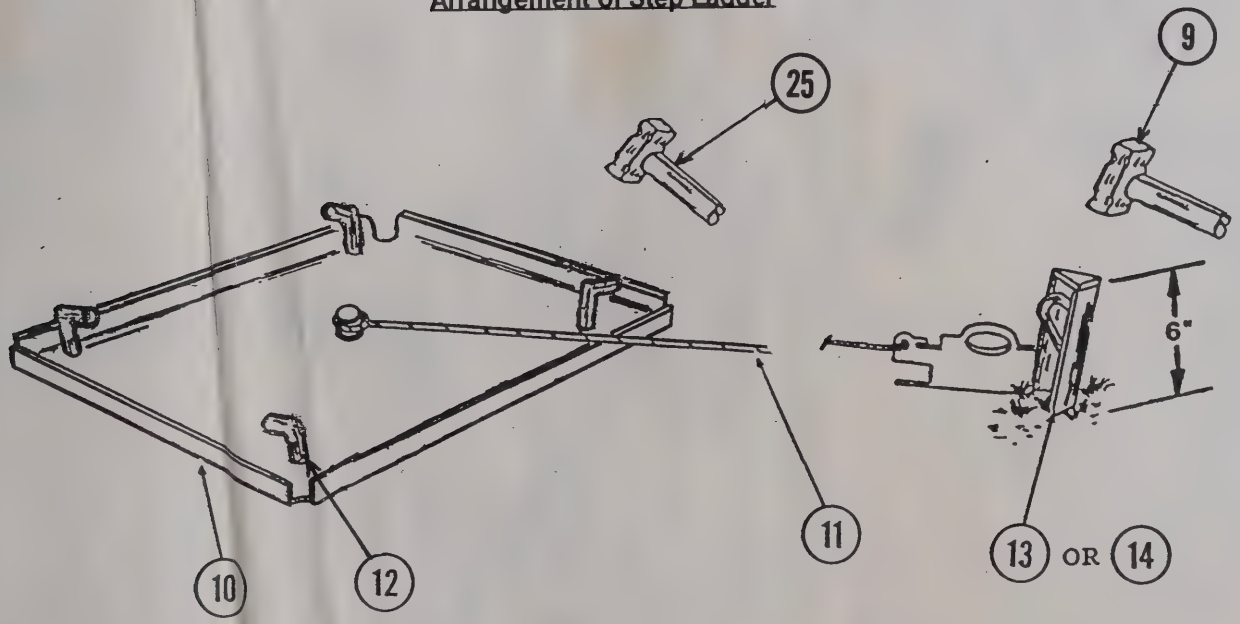


Figure 2-6. Base Plate Installation

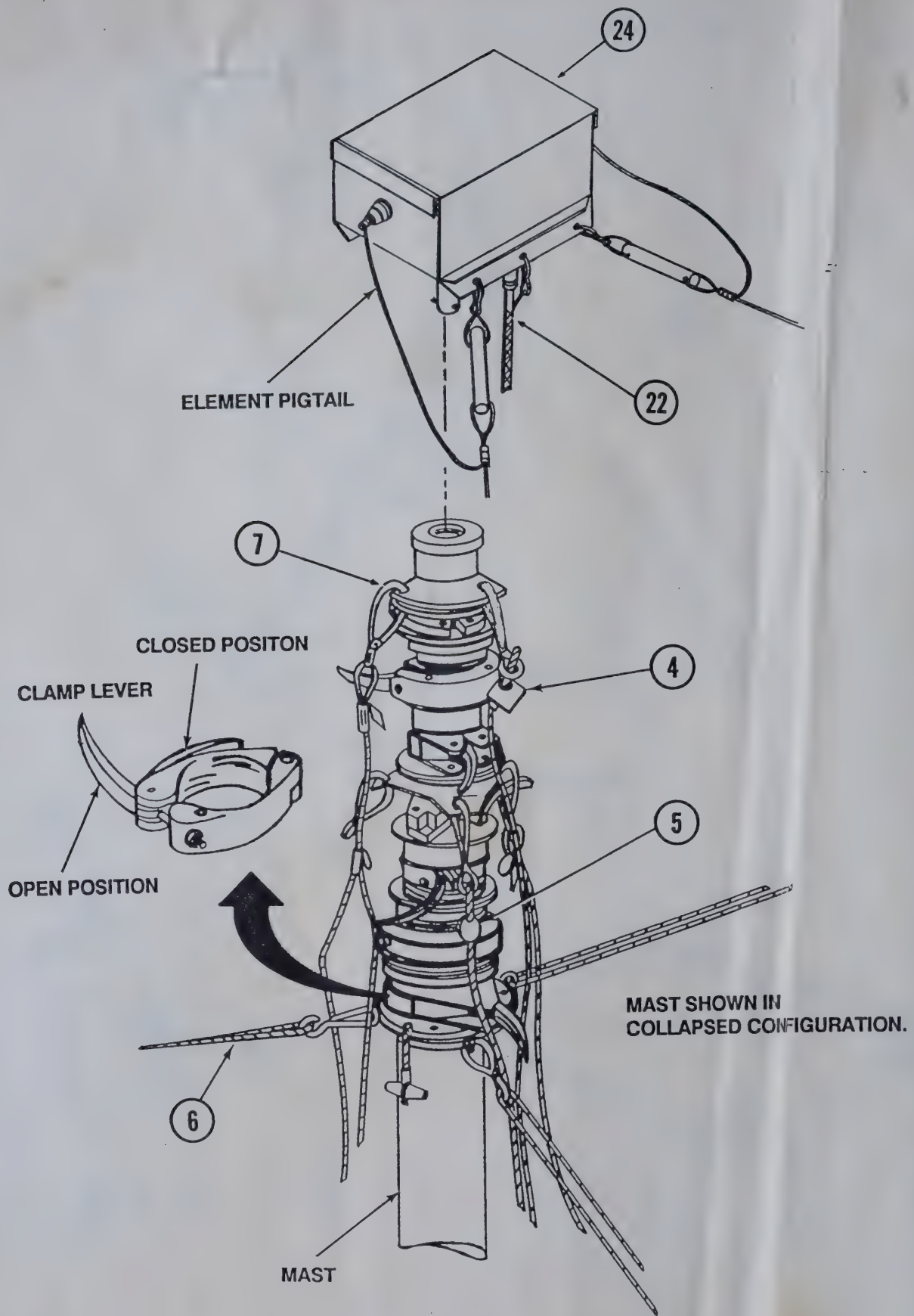
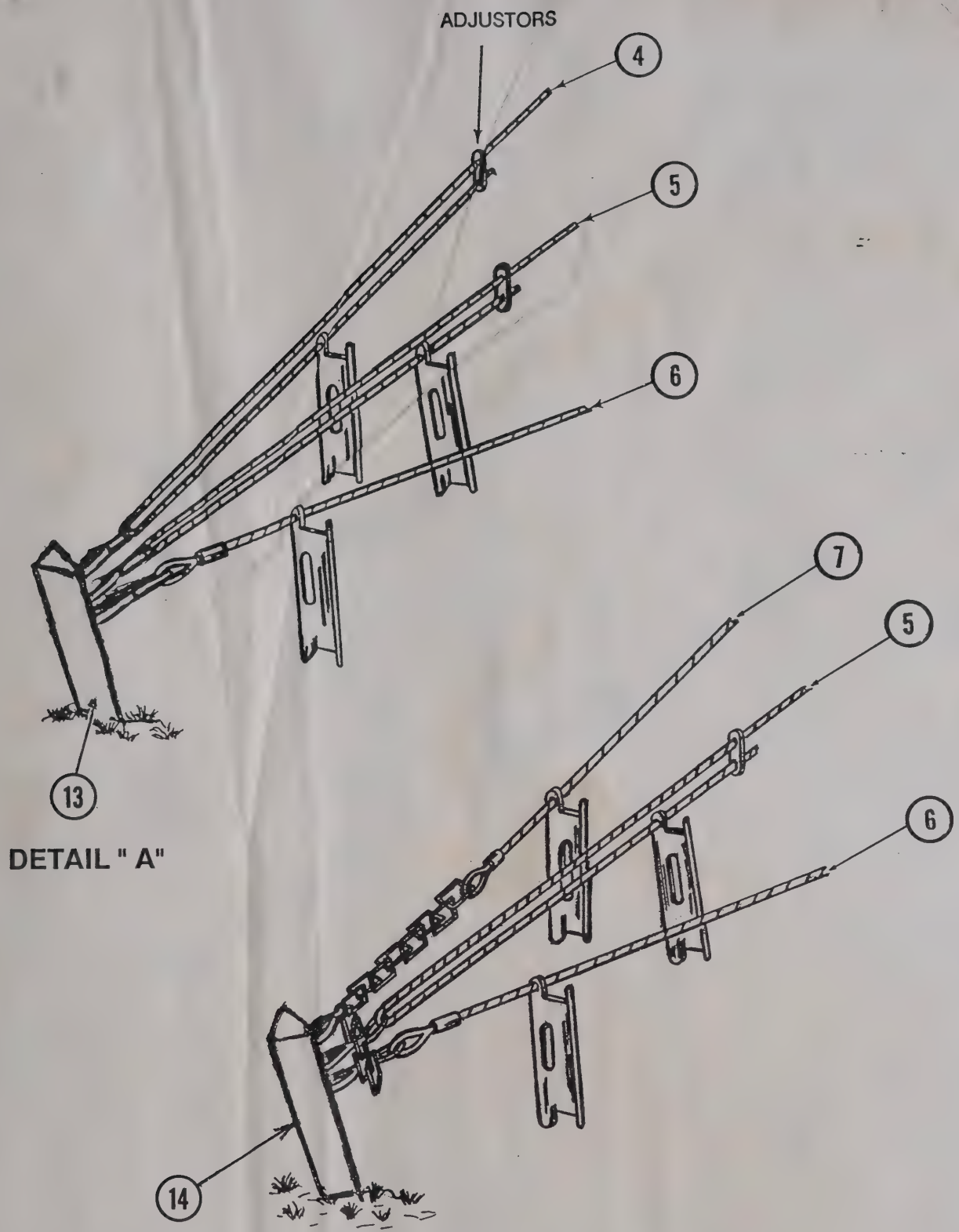


Figure 2-7. Mast Installation



DETAIL " A"

DETAIL "B"

TOP BACK GUY

Figure 2-8. Guy to Anchor

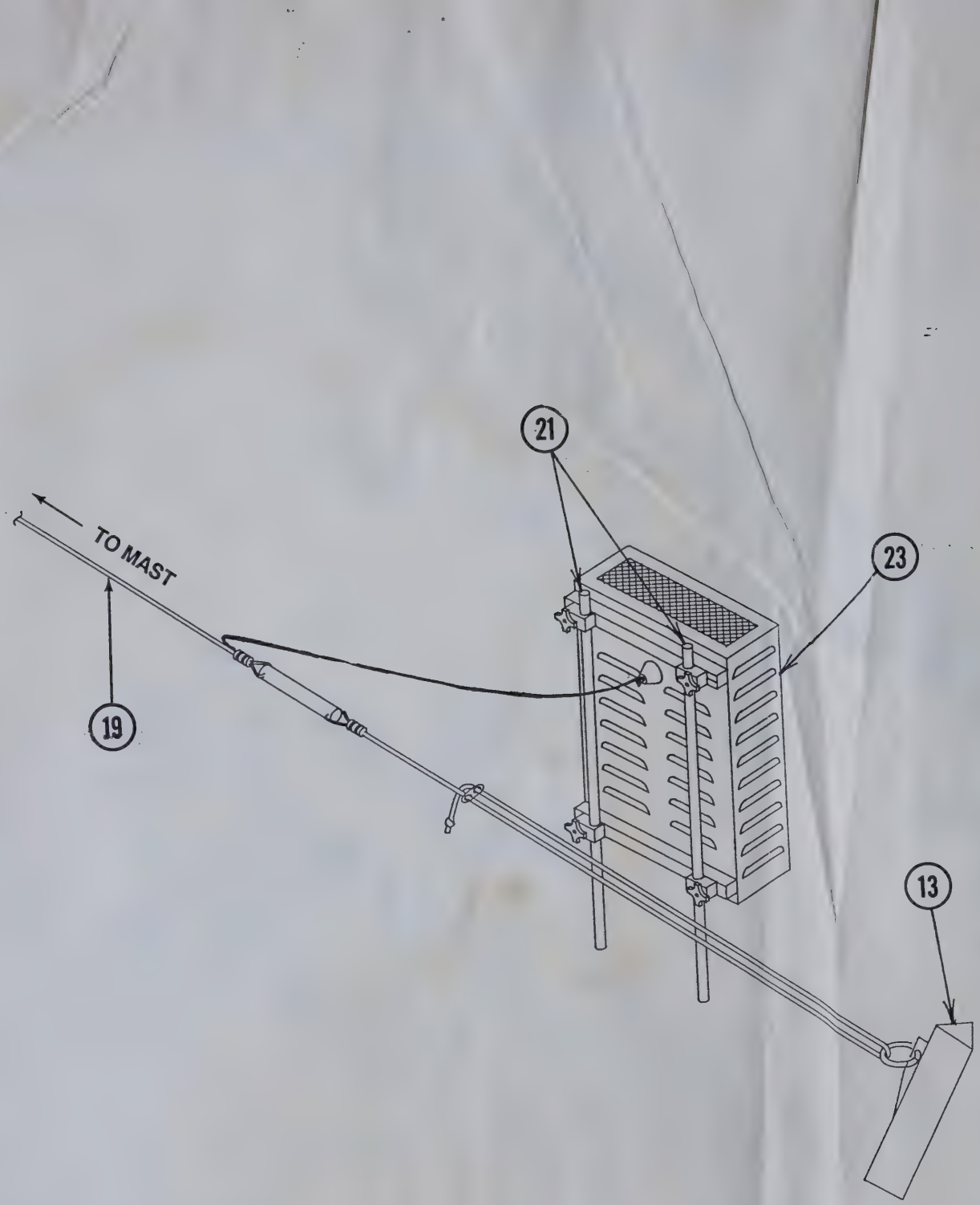


Figure 2-9. Termination Installation

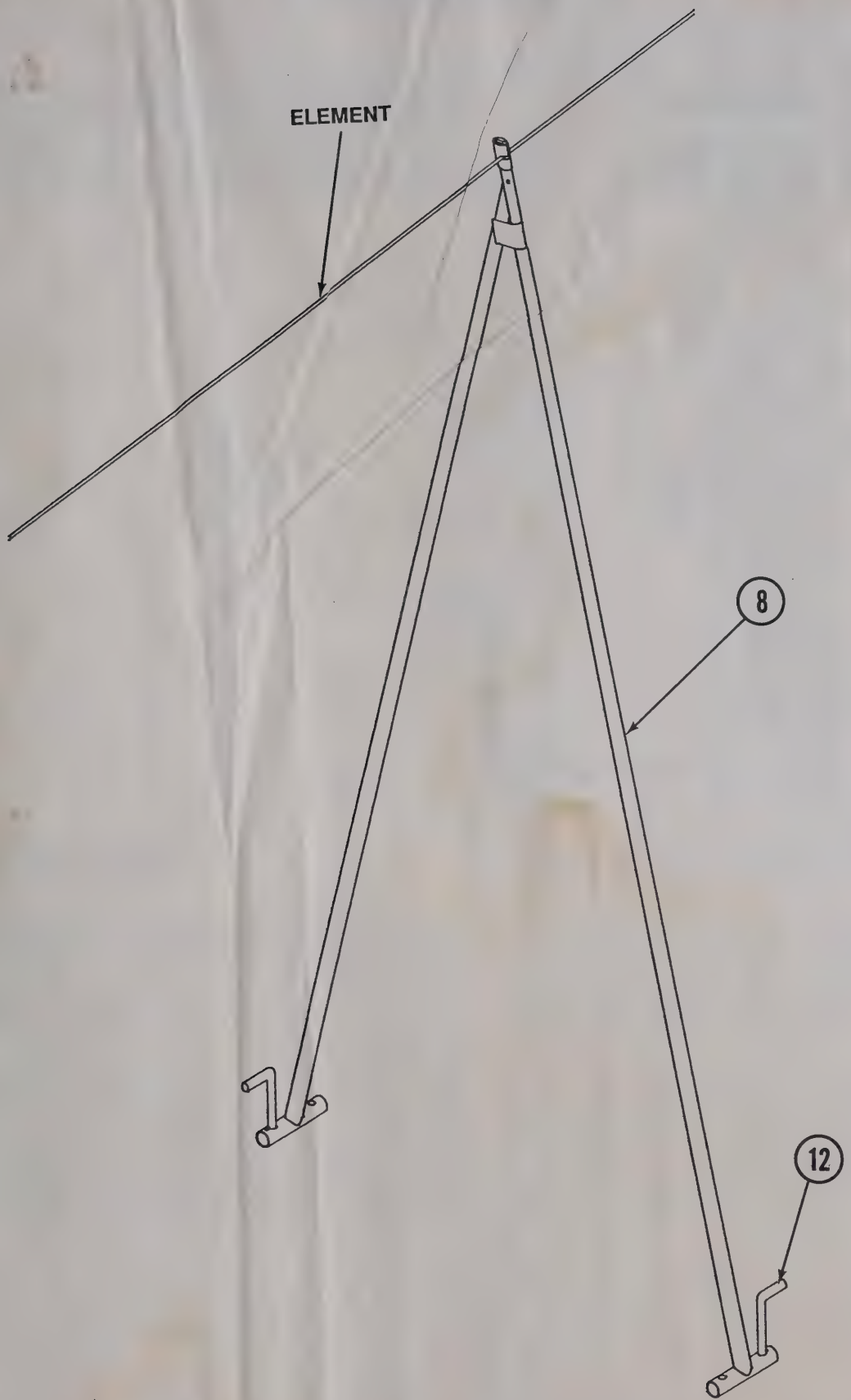


Figure 2-10. Front Pole Installation

VH-830 TM/2 ANTENNA PARTS LIST

ITEM NO.	PART NUMBER	DESCRIPTION	QTY
	1500-0267-201	Systems Items, VH-830 Antenna	1
1	1000-1007-201	. Mast, 15m, PM457, w/Case	1
2	1000-1279-201	. Accessory Items	1
3	0003-0614-201	. . Guy Kit	1
4	0003-0419-301	. . . Top Guy Assembly	2
5	0003-0419-302	. . . Middle Guy Assembly	3
6	0003-0419-303	. . . Lower Guy Assembly	3
7	0003-0613-201	. . . Top Back Guy Assembly	1
8	0003-0428-201	. Pole Assembly	2
9	2450-2251-005	. . Hammer, Sledge	1
10	0003-0507-301	. . Base Plate Assembly	1
11	0003-0420-201	. . Line, Radius	1
12	0003-0508-201	. . Pin, Mast Plate	10
13	0002-8847-303	. . Stake, Guy	4
14	0003-2443-301	. . Stake, Top Back Guy	1
15	0003-0548-301	. . Ladder Assembly	1
16	0003-0555-201	. . Strap, Coax	6
17	2450-2248-001	. . Foot Pump (Not Shown)	1
18	1000-1176-201	. Antenna Items	1
19	0003-2444-303	. . Element Assembly	2
20	0003-0439-201	. . Line, Radius, Element Assy	1
21	0003-4195-201	. . Post, Termination	4
22	0003-0544-201	. . Coax Assembly	1
23	1000-1431-401	. Termination, RX-15	2
24	1000-1177-401	. Balun, SM-207	1
25	2450-2247-001	. . Hammer, Hand	1

CHAPTER 3. MAINTENANCE

3-0 THEORY OF OPERATION.

3-1 GENERAL. The VH-830 TM/2 is a terminated "Vee" antenna designed for medium to long range sky wave circuits. The antenna is intended for use in the 8 to 30 MHz frequency band. Operation is extended down to 2 MHz with reduced performance. The VH-830 antenna is horizontally polarized for efficient performance over all types of soil. The antenna is fed with a 50/800 ohm balun that is located at top of the telescoping mast. Its radiation characteristics stem from the fact that currents of nearly constant amplitude flow in the two wires of the "Vee". Radiation characteristics of the wires are depicted in Figure 3-1, Terminated "Vee" Antenna.

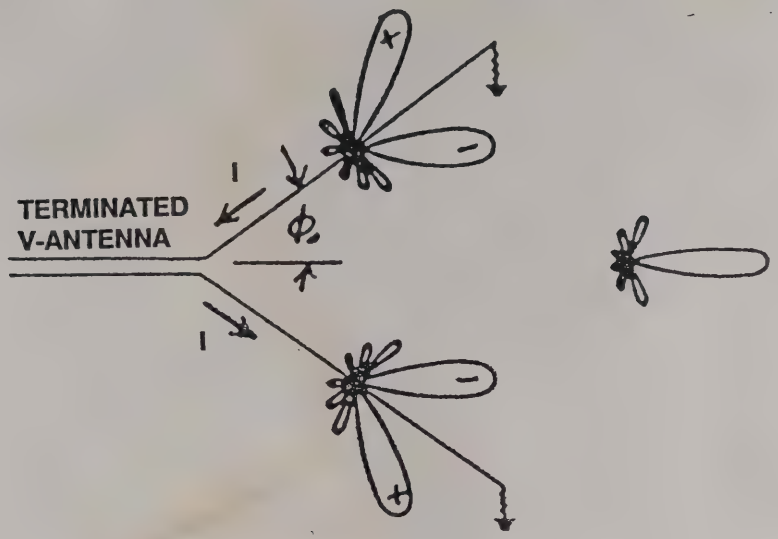


Figure 3-1. Terminated Vee Antenna

3-2 ANTENNA THEORY.

3-2.1 Antenna Curtain. The amount of power radiated by the antenna is dependent upon the length of the wires in wavelengths. The differences between the input power and the radiated power is dissipated in the termination resistors. The terminations are rated for 2.0 kW each for a total of 4.0 kW. Therefore, the input power must be limited so that these ratings are not exceeded. Figure 3-14 shows the percent power radiated as a function of frequency for a given input power. At an operating frequency of 8 MHz and for a leg length of 500 feet, the power radiated is 50% of input. Therefore, the power dissipated in the loads is 50% of input as shown in Figure 3-15. At lower frequencies or for shorter leg lengths, the input power must be reduced to keep from exceeding the rating of the terminations.

3-2.2 Impedance. The input impedance of the antenna is 800 ohms and the two wires are terminated in two 450 ohms terminations. The input VSWR is less than 2.0:1 for frequencies between 2 and 30 MHz. A VSWR versus frequency is shown in Figure 3-13.

3-2.3 Patterns. Radiation patterns showing the azimuth and elevation coverage are provided in Figures 3-3 through 3-12 for 8, 13, 16, 20 and 25 MHz respectively. The patterns are plotted in power gain referenced to an isotropic radiator (dBi).

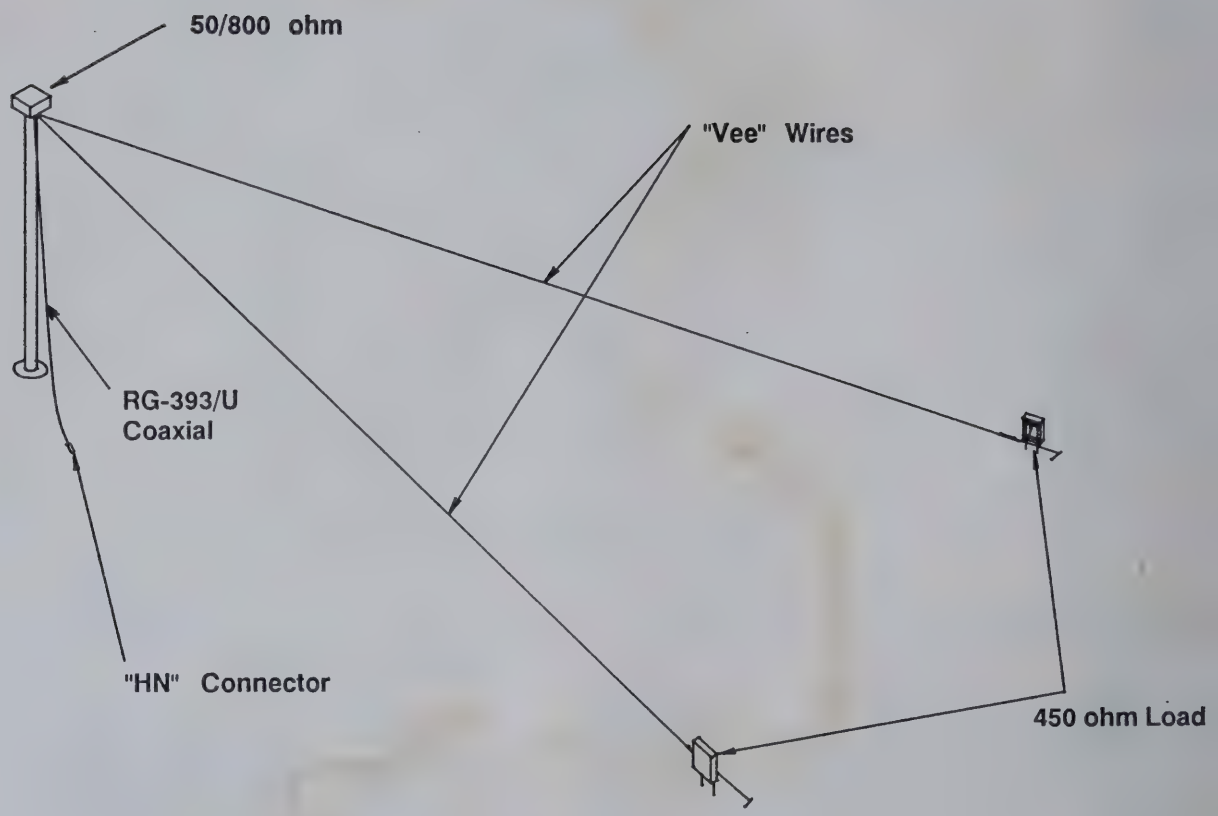


Figure 3-2. "Vee" Antenna and RF Interface

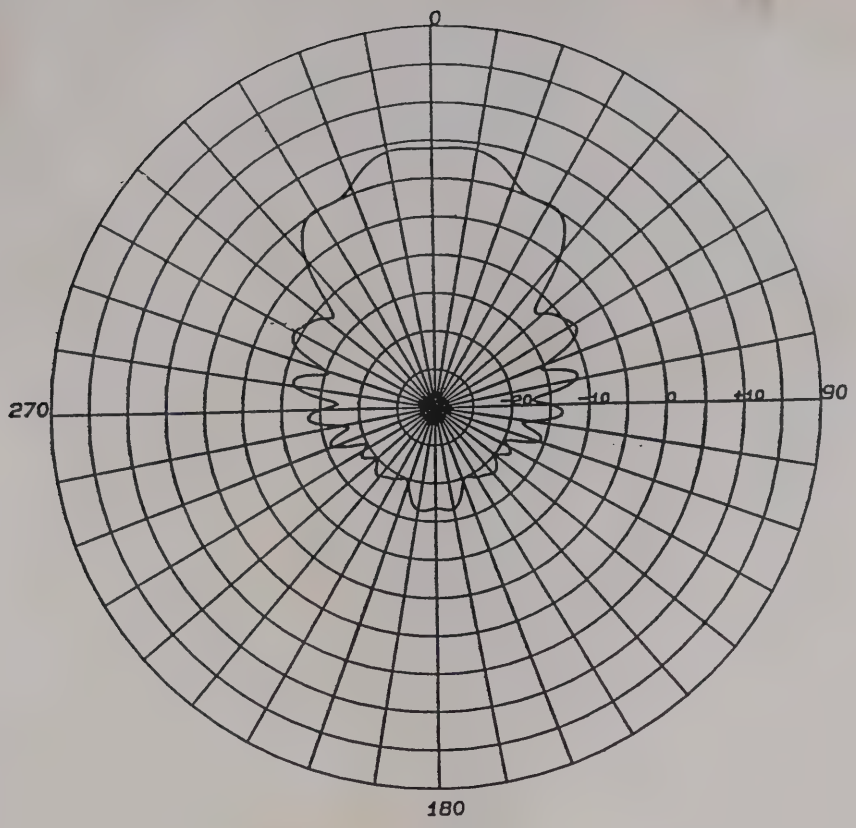


Figure 3-3. Azimuth Pattern, dBi, 8 MHz

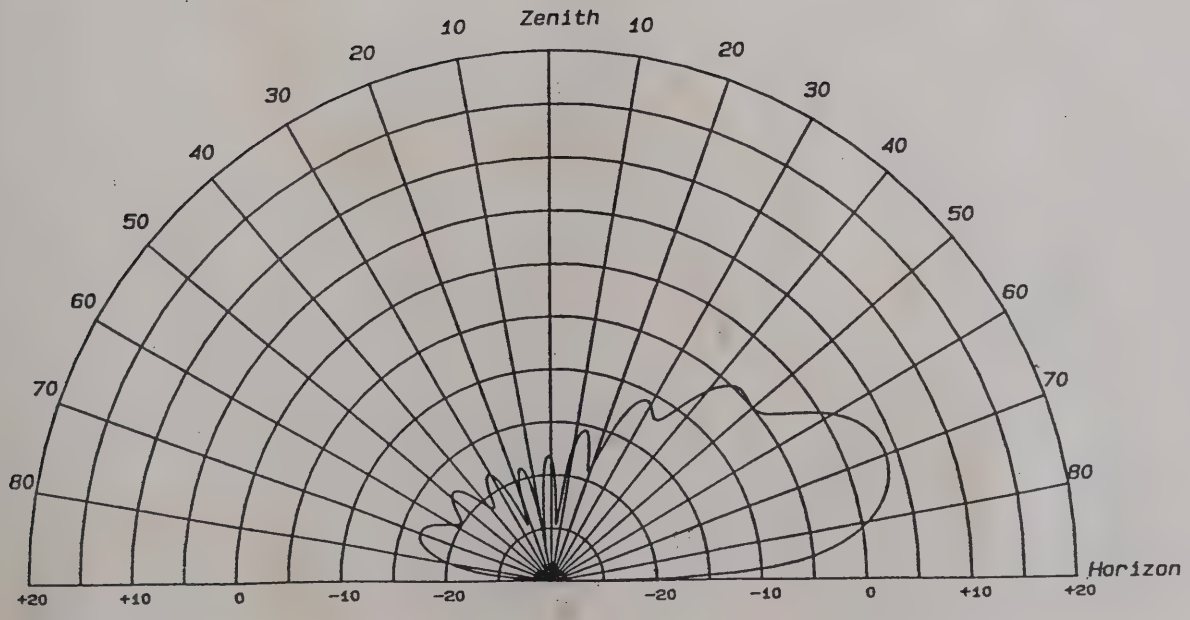


Figure 3-4. Elevation Pattern, dBi, 8 MHz

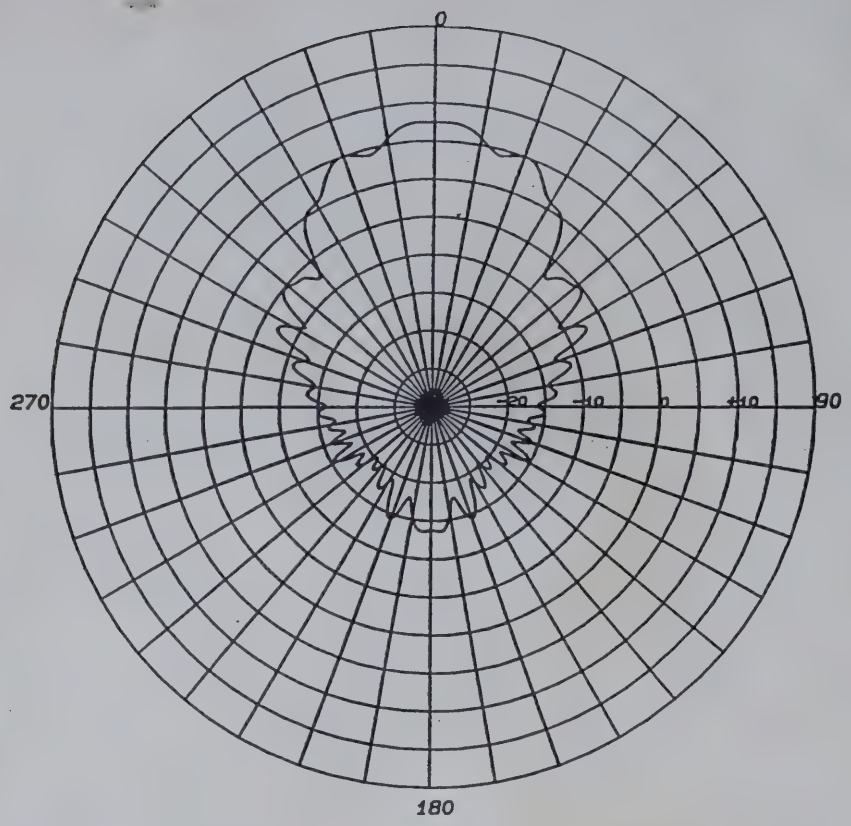


Figure 3-5. Azimuth Pattern, dBi, 13 MHz

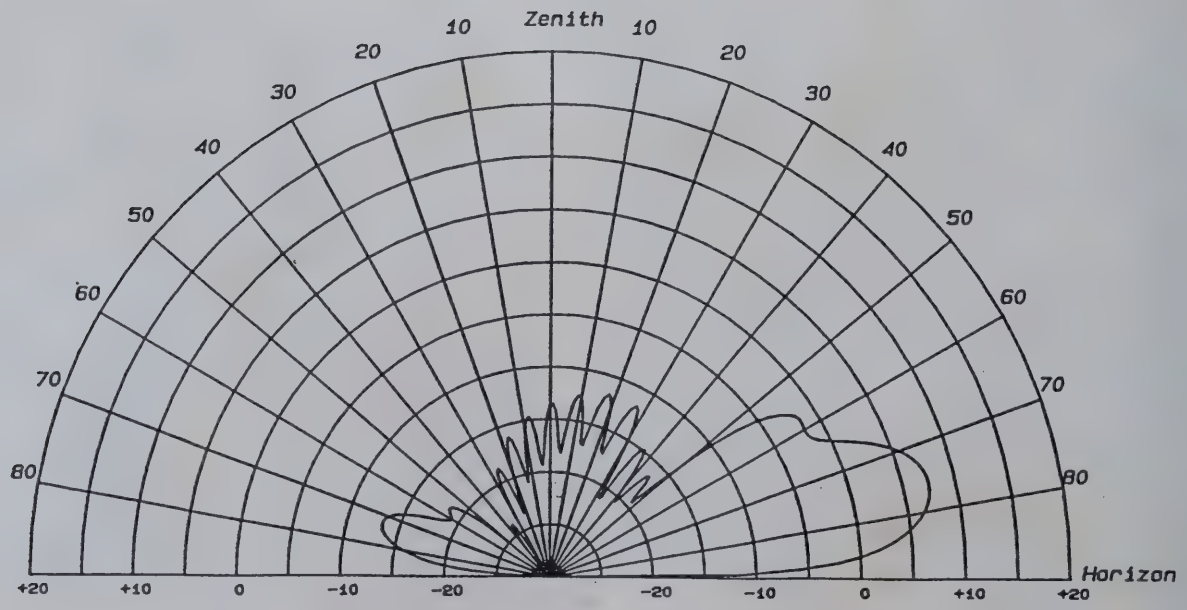


Figure 3-6. Elevation Pattern, dBi, 13 MHz

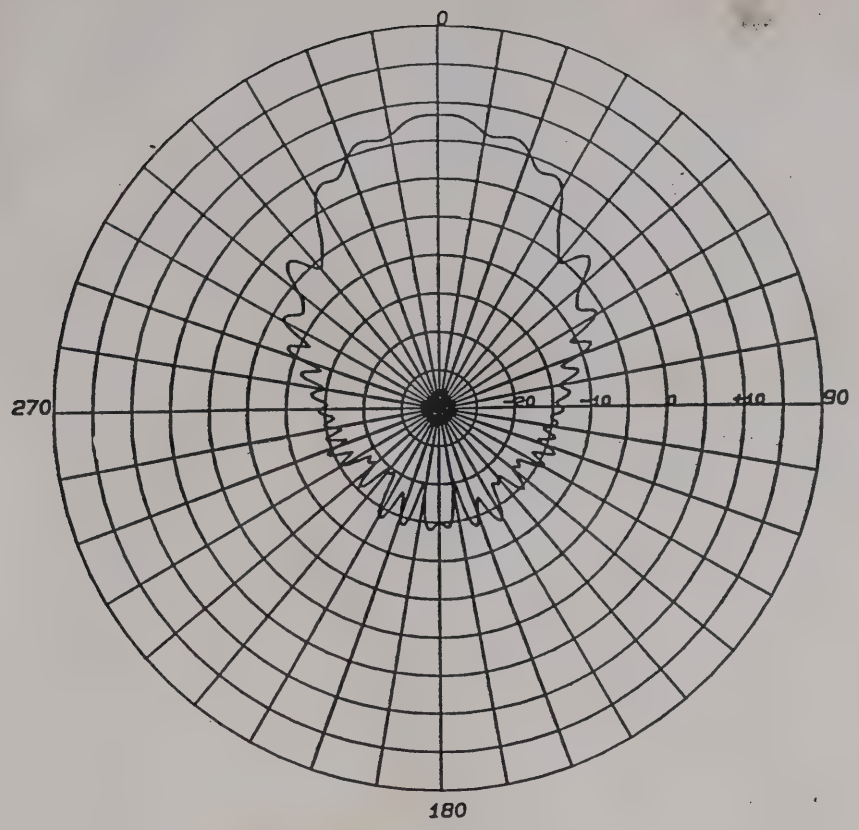


Figure 3-7. Azimuth Pattern, dBi, 16 MHz

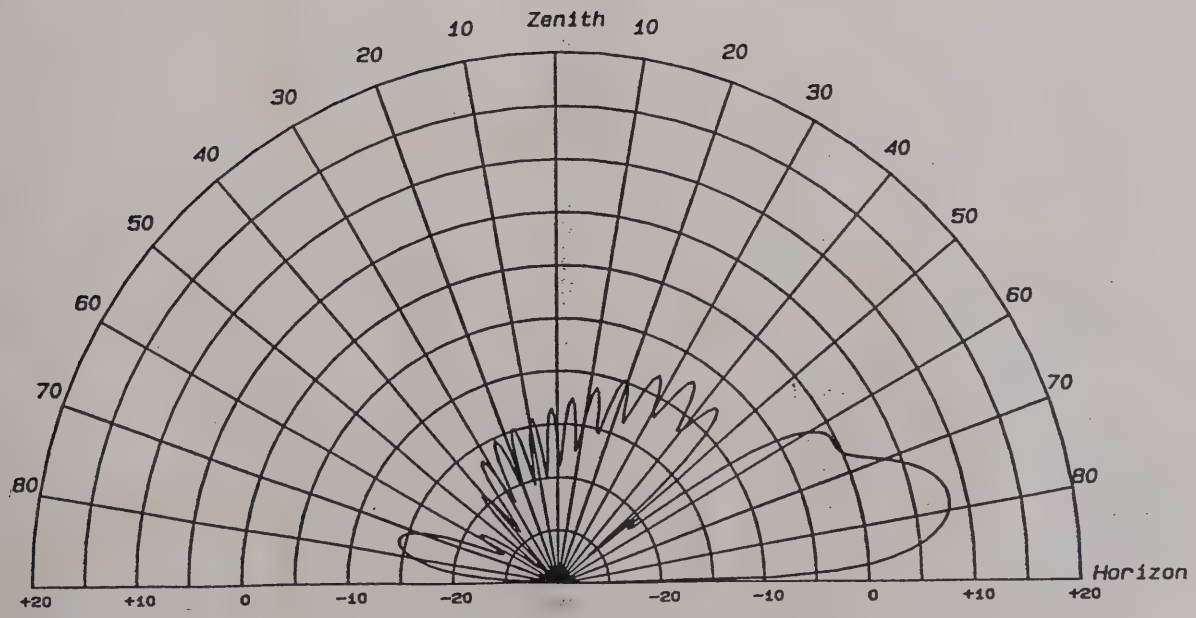


Figure 3-8. Elevation Pattern, dBi, 16 MHz

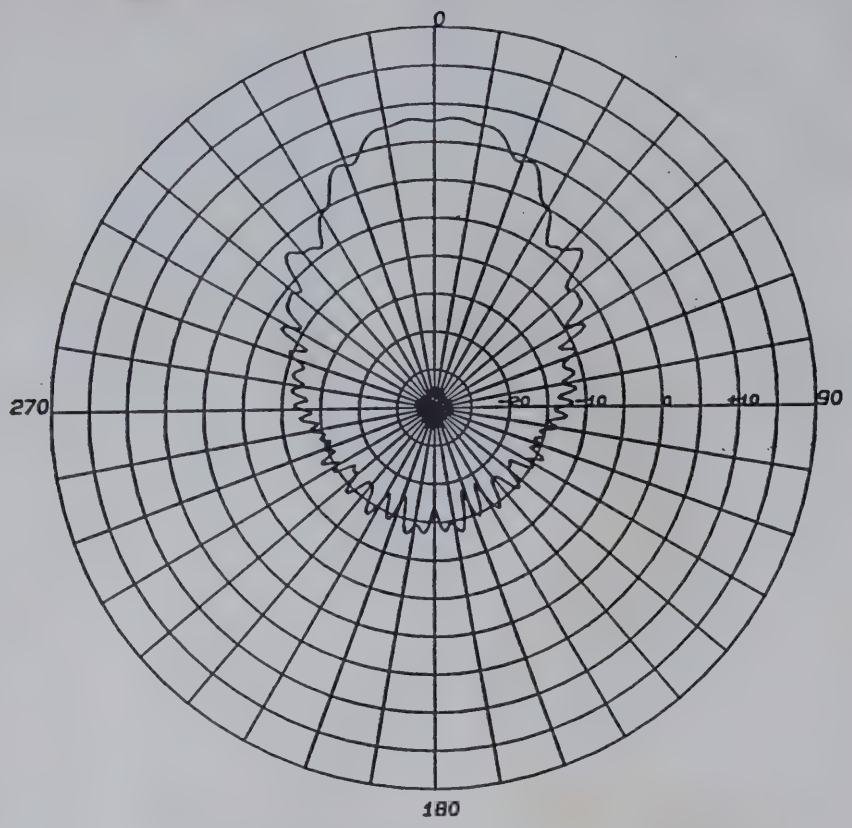


Figure 3-9. Azimuth Pattern, dBi, 20 MHz

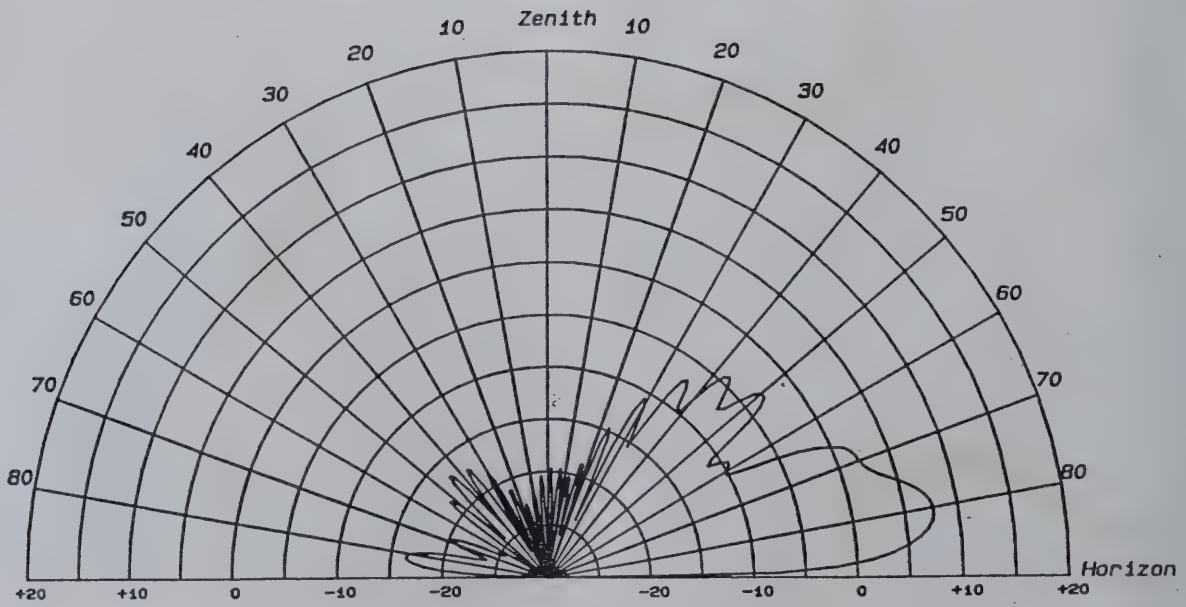


Figure 3-10. Elevation Pattern, dBi, 20 MHz

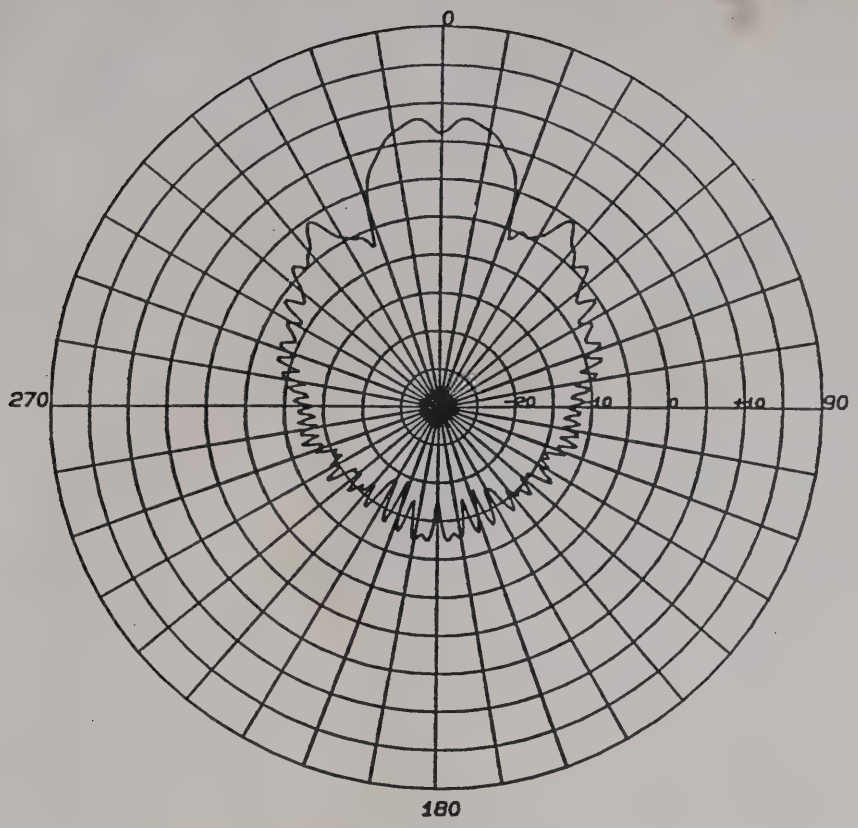


Figure 3-11. Azimuth Pattern, dBi, 25 MHz

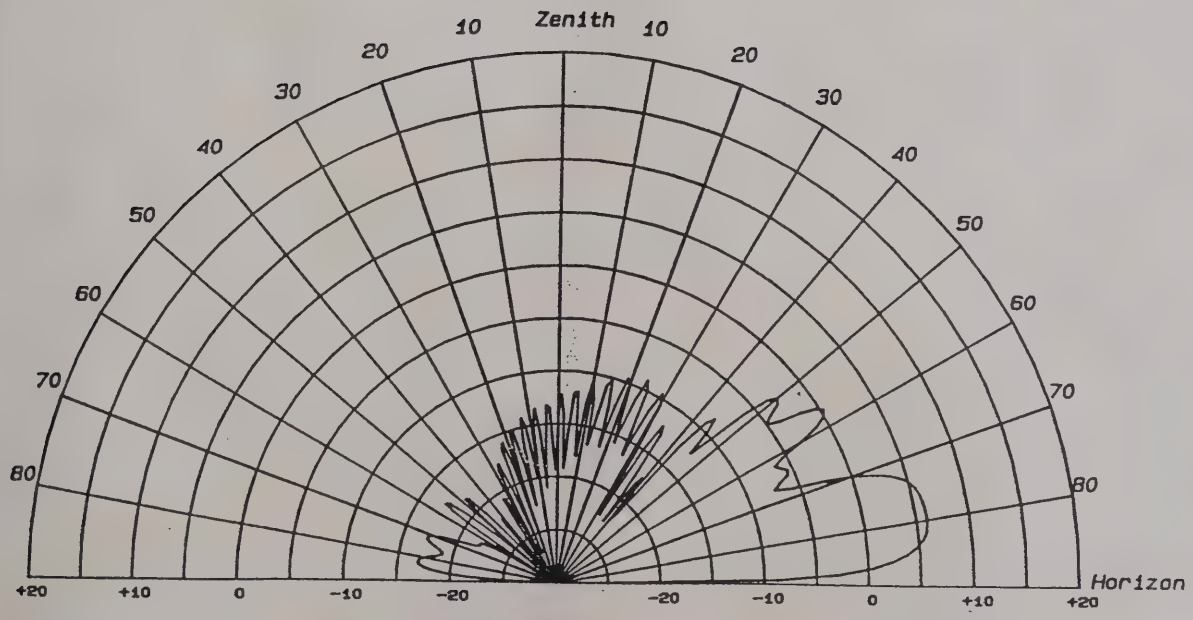


Figure 3-12. Elevation Pattern, dBi, 25 MHz

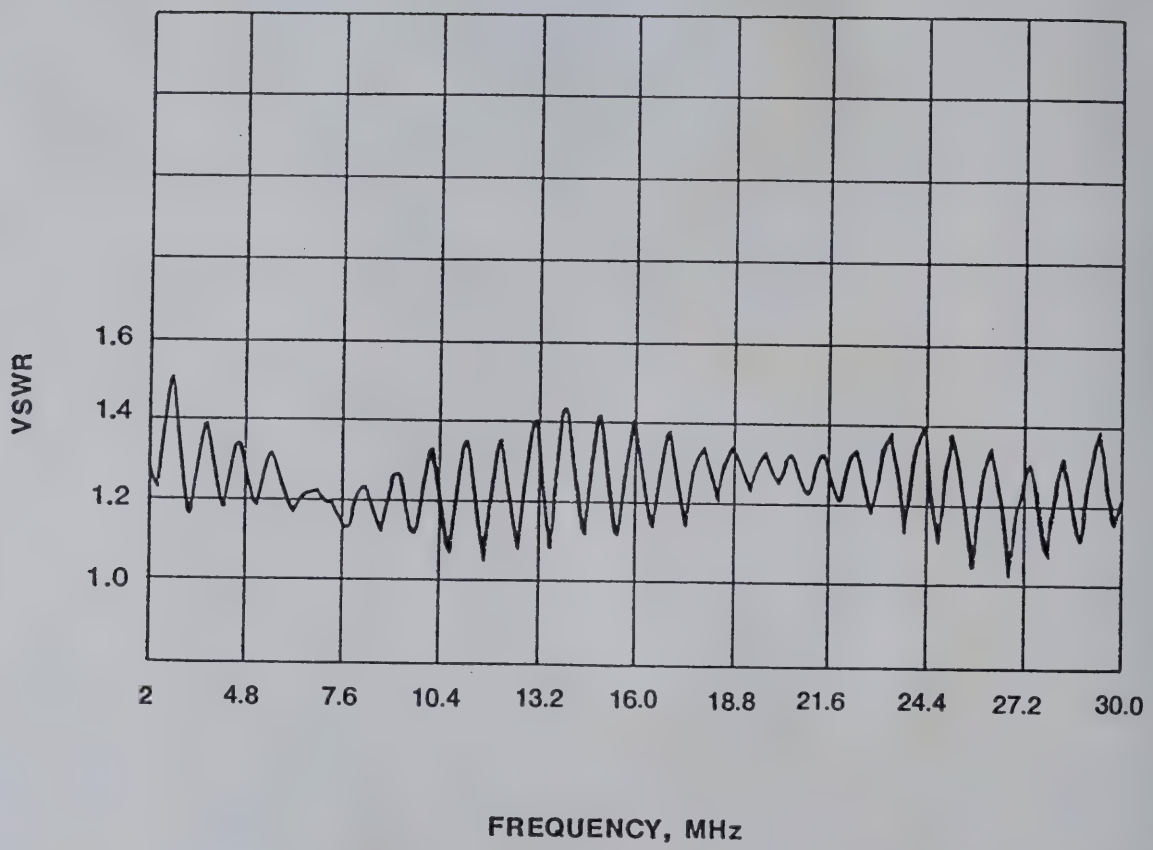


Figure 3-13. VSWR vs Frequency

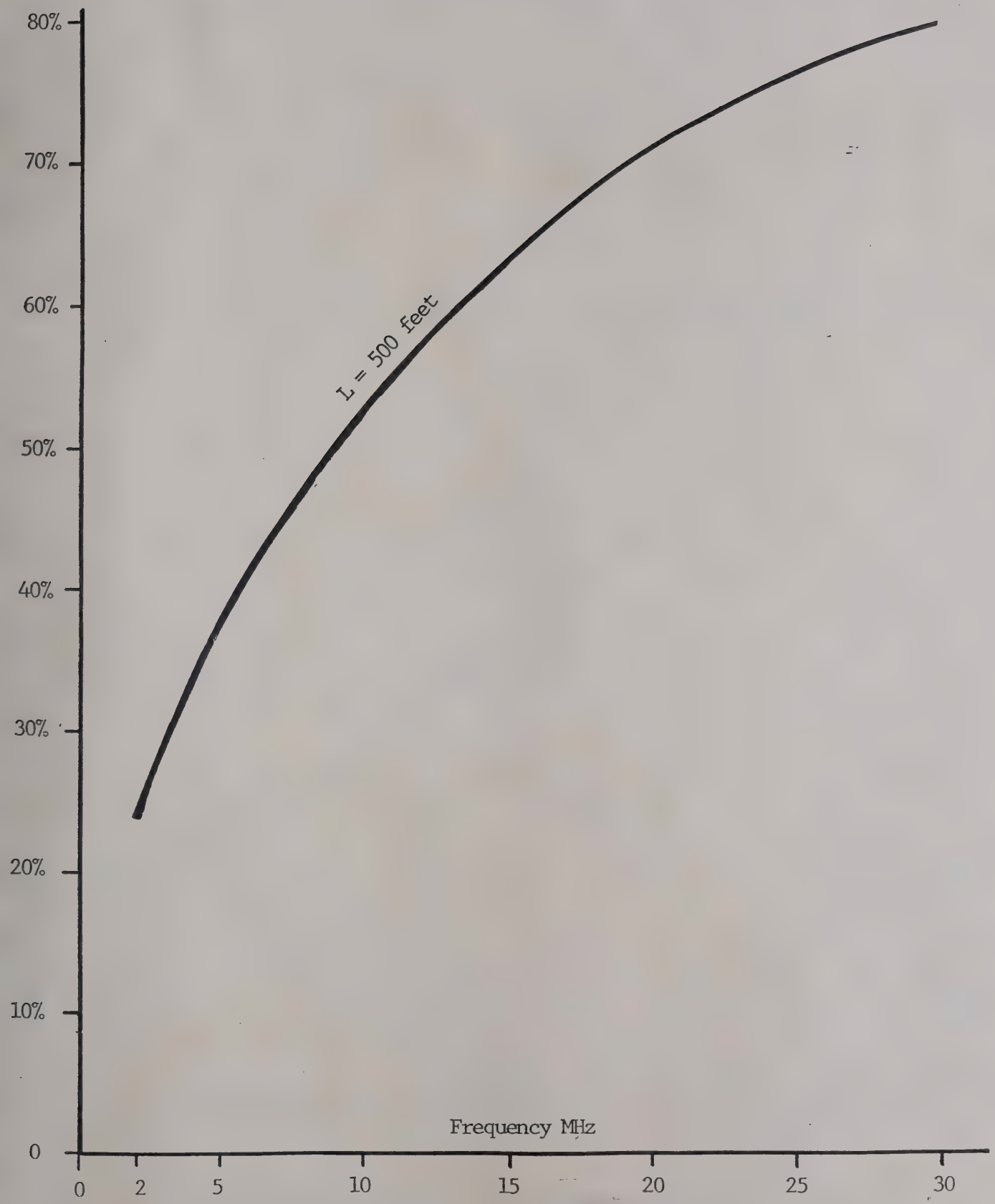


Figure 3-14. Radiation Efficiency

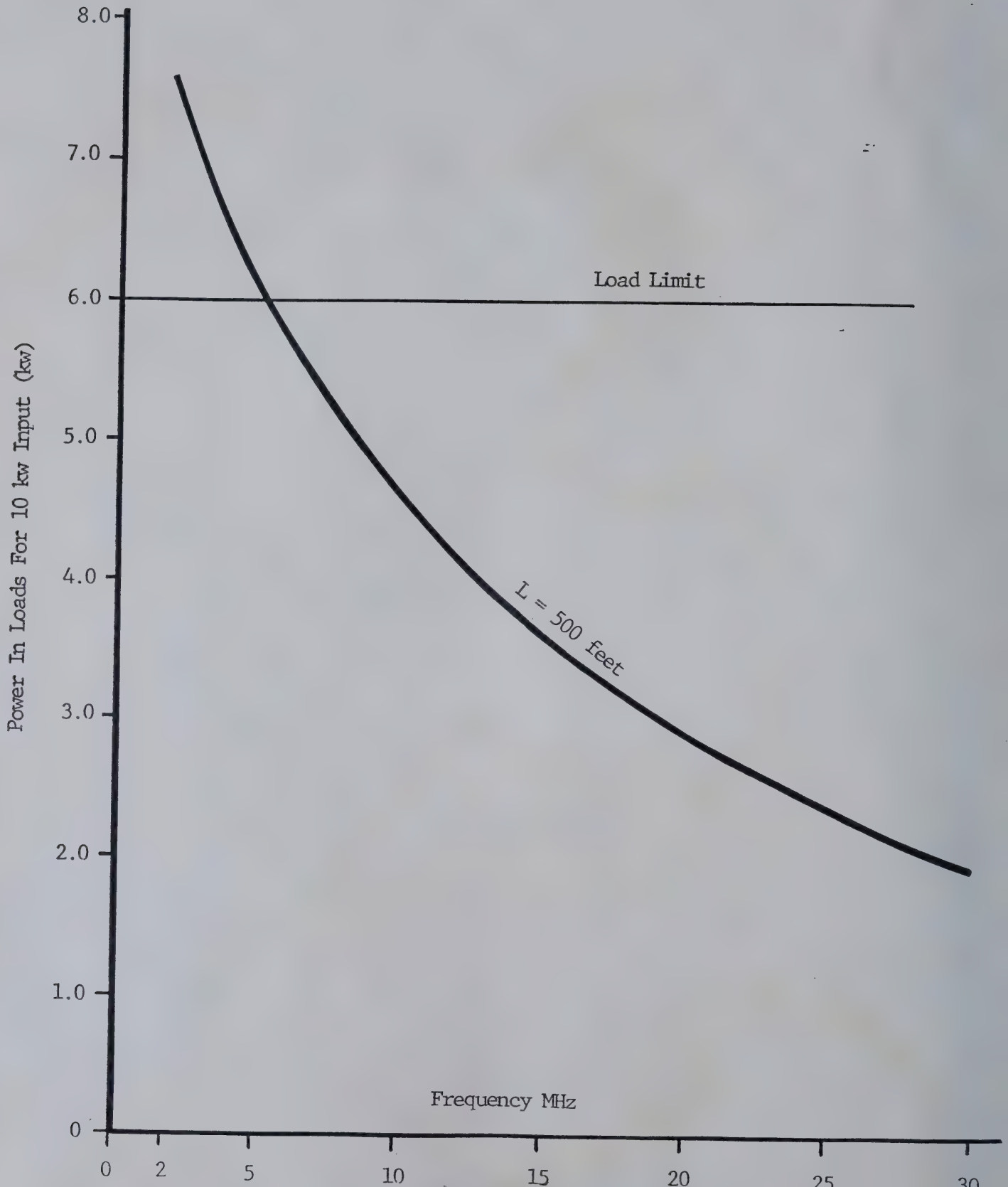


Figure 3-15. Power in Loads for (10 kW) Antenna

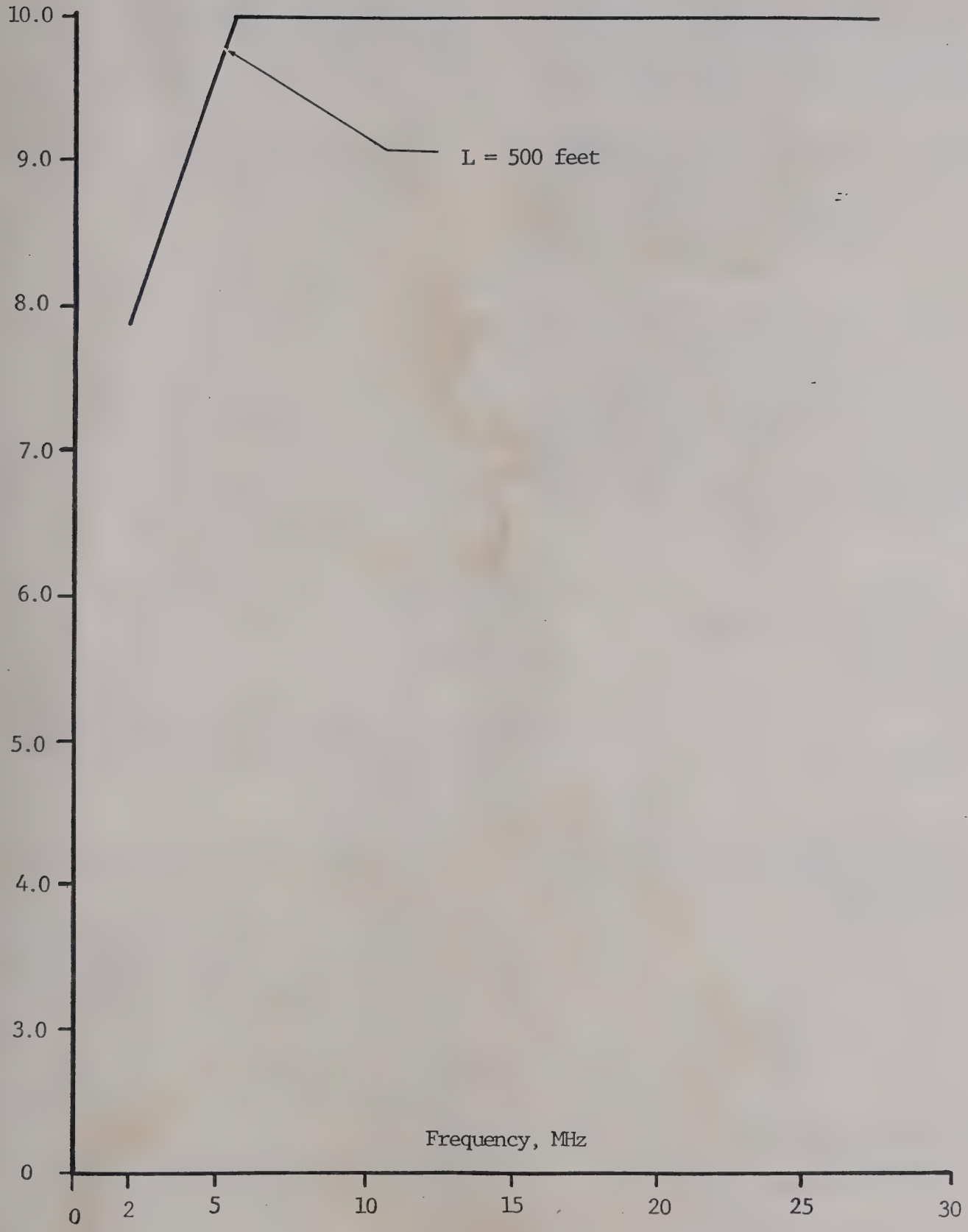


Figure 3-16. Maximum Transmitter Power

3-3 ANTENNA VSWR PERFORMANCE CHECK.

3-3.1 General. Prior to the antenna being placed in service a VSWR check must be performed as described below.

3-3.2 Purpose. The purpose of this test is to evaluate the installed antenna system. The performance requirement is designed to detect high voltage standing wave ratios (VSWR) which result in a reduction in overall transmission efficiency. This performance requirement should be performed on an "as required" basis.

3-3.3 Method. The VSWR of an antenna can be determined from return loss measurements. Return loss versus frequency measurements, using swept frequency techniques, is possible with network analyzers such as the HP-8505A and the HP8753A. The network analyzers have a rather simple zeroing procedure involving the use of either a short or open on the coaxial input to the analyzer. The procedure is provided with the particular network analyzer. The return loss, VSWR, and voltage reflection coefficient are defined as follows:

$RL = 20 \log_{10} (p)$,dB

where p = voltage reflection coefficient

$10^N = p$, $N = RL/20$

$VSWR = (1 + p) / (1 - p)$

$p = (VSWR - 1) / (VSWR + 1)$

Sometimes in the field, test equipment is not available but transmitters are available with indicators which provide forward and reflected power. In this case the VSWR can be obtained as follows:

$$VSWR = \frac{1 + \sqrt{\frac{P_R}{P_F}}}{1 - \sqrt{\frac{P_R}{P_F}}}$$

P_R = Power Reflected, Watts

P_F = Power Forward, Watts

3-4 TEST EQUIPMENT REQUIRED.

a. HP Spectrum Analyzer to include the following:

(1) HP-8443A Tracking Generator

(2) HP-8553B RF Section

(3) HP-8552B IF Section

(4) HP-141T Display Section

b. HP-197 Oscilloscope Camera or Equivalent

c. HP-8721A Coaxial Directional Coupler or Equivalent

d. HP-8491B 30 dB Coaxial Attenuator or Equivalent

e. Non-Inductive, Precision Terminating Resistors, in BNC Type Connectors, with the following values:

(1) $Z_R = Z_O =$ 50 ohms (1:1 ratio)

(2) $Z_R = 3Z_O =$ 75 ohms (1.5:1 ratio)

(3) $Z_R = 2Z_O =$ 100 ohms (2:1 ratio)

where

Z_O is the characteristic impedance of the transmission line under test, 50 ohm, Z_R is the impedance represented by the non-inductive terminating resistors.

3-5 PROCEDURE.

a. Initial settings of Spectrum Analyzer controls are shown in Table 3-1.

b. Establish the test set-up as shown in Figure 3-17. Calibrate the X-Y Recorder to obtain linearity throughout the dynamic range of the 8552B. It may be necessary to decrease the input attenuation of the 8553B to attain the desired results.

c. Adjust the center frequency for 10 MHz $\pm$ 5 KHz. Change the scan time/division to 1 sec/div. Switch the scan mode to single scan.

d. Plot calibration lines for the 2:1 and 1.5:1 mismatches. Change the scan time/division to 10 sec/div.

e. Terminate the load side of the coaxial directional coupler with the antenna under test. Actuate the single scan button and plot the antenna VSWR. Repeat the above procedures using 28 MHz $^{+}$ 5 KHz as the center frequency.

f. The "X" axis should be annotated at three or more points. This can be accomplished by operating the HP-8552B in the Manual Scan mode. With the HP-8443A Tracking Generator in the Scan Hold position, the calibration of frequency can be determined directly by manually scanning and reading the frequency at each point.

g. With the transmission line disconnected from the antenna, plot line insertion loss versus frequency on the same graph used for VSWR.

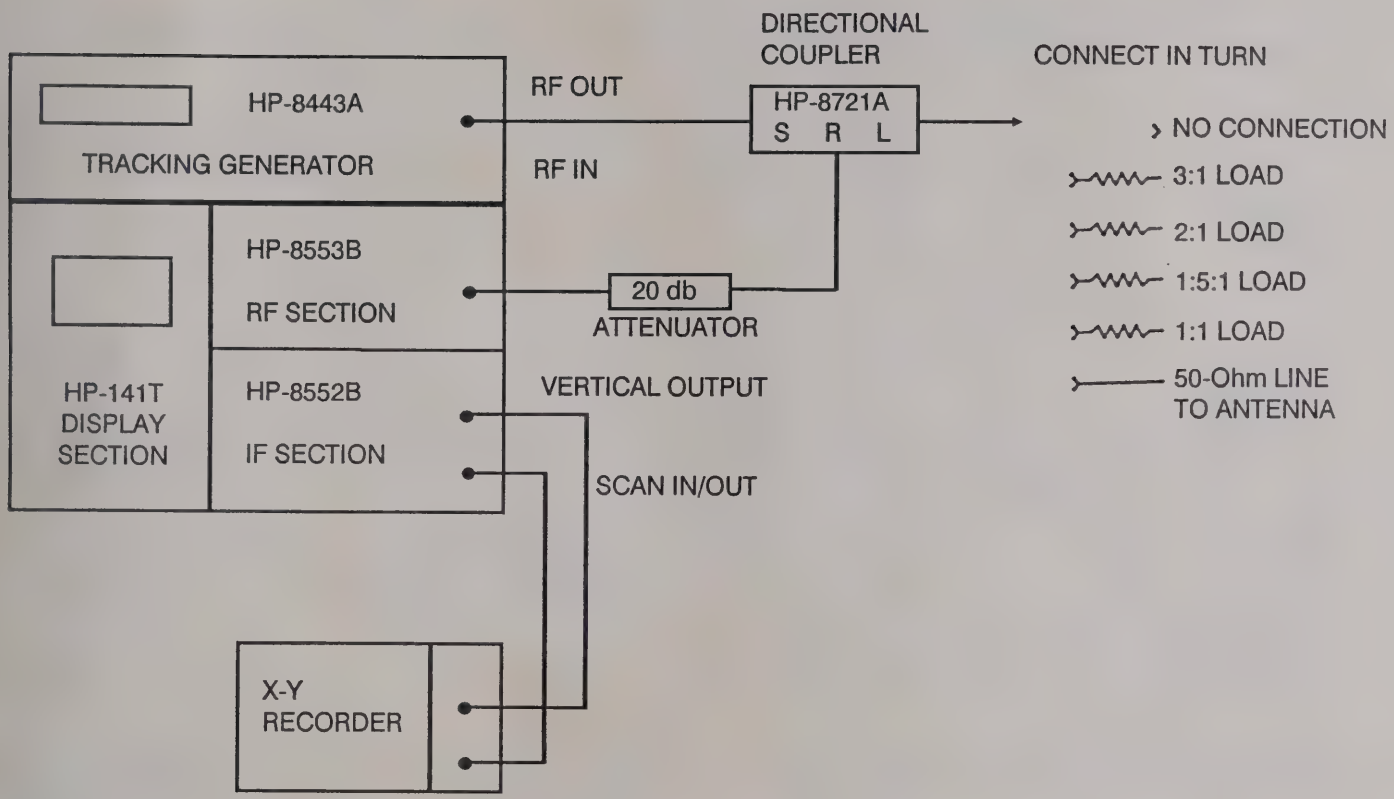


Figure 3-17. Test Set-Up

Table 3-1. Spectrum Analyzer Control Settings

SECTION	STEP	SELECTOR	INITIAL POSITION
	1	Range MHz	0-110 MHz
	2	Frequency	10 MHz
HP-8553B	3	Tuning Stability	OFF
RF	4	Bandwidth	10 KHz
Section	5	Scanwidth/Division	2 MHz (per division mode)
	6	Input Attenuation	10 dB
	7	Baseline Clipper	Fully CCW
	8	Video Filter	10 Hz
	9	Scan Time/Division	1 msec
HP-8552B	10	Scan Mode	Internal
IF	11	Log Reference Level	-30 dB
Section	12	Log/Linear Switch	10 dB Log
	13	Log Ref Level Vernier	Fully CCW (0 dB)
	14	Scan Trigger	AUTO
	15	Storage/Non-Storage	Non-Storage Conv
HP-141T	16	Time	Fully CCW
Display	17	Persistence	Fully CCW
Section	18	Intensity	As Needed
	19	Focus	As Needed
	20	Marker Intensity	Fully CCW
	21	Mode	Marker
HP-8443A	22	Resolution	10 Hz
Tracking	23	Marker Position	Pulled Out
Generator	24	RF Output Level	-10 dBm
	25	Function (IF Equipped)	Track Analyzer
	26	*Shutter	Closed
HP-197A	27	*Shutter Speed	Time
or C-30*	28	*f Stop	5.6
Camera	29	Flash Intensity	Mid-Range
	30	Illumination	Flash

CHAPTER 4. THEORY OF OPERATION

4-0 MAINTENANCE SCHEDULE

NOTE

THE TELESCOPING MAST UTILIZES ANODIZED TUBE SECTIONS TO INSURE SMOOTH TRAVEL AND OPERATION, DO NOT PAINT THE MAST ASSEMBLY AS THIS WILL INTERFERE WITH PROPER MAST OPERATION.

4-1 **90-DAY INTERVAL.** The following maintenance should be required during periods of extended field use.

a. Wipe dirt and moisture from extended mast sections and apply a light coat of oil with an oil saturated cloth.

b. Check that the drain hole at the base of the mast is clear.

4-2 **6-MONTH INTERVAL.** The following maintenance should be completed during periods of 6-month field use.

a. Wipe dirt and moisture from extended mast sections and apply a light coat of oil with an oil saturated cloth.

b. Check that the drain hole at the base of the mast is clear.

c. Check all guys and the halyard for fraying and replace when necessary.

d. Check the pneumatic damping of the mast per the instructions. If the descent time is not within the recommended time span, adjust the restrictor accordingly.

NOTE

IF THE MAST SECTIONS DESCEND RAPIDLY AND ADJUSTMENT OF THE RESTRICTOR DOES NOT CORRECT THE PROBLEM, THEN THE MAST MUST BE DISASSEMBLED PER THE MAINTENANCE INSTRUCTIONS AND THE PISTON ASSEMBLIES OILED. AFTER THE MAST HAS BEEN REASSEMBLED, CHECK THE DESCENT TIME AND ADJUST THE RESTRICTOR ACCORDINGLY.

4-3 **EXTENDED STORAGE.** When a mast is removed from the extended storage (6 months or greater), the following maintenance should be completed prior to field use.

a. Wipe dirt and moisture from extended mast sections and apply a light coat of oil with an oil saturated cloth.

b. Check that the drain hole at the base of the mast is clear.

c. Check the pneumatic damping of the mast per the instructions. If the descent time is not within the recommended time span, adjust the restrictor accordingly.

4-4 TELESCOPIC MAST - 15M.

4-4.1 Tools Needed.

Hexagonal Wrench for Socket (M3) 2.5mm A/F
Hexagonal Wrench for Socket (M5) 4mm A/F
Tubular Box Spanner (M5) 8mm A/F
Pin Punch 2.4mm dia.
Hammer (soft head)
Melinex Sheet
External Circlip Pliers

4-4.2 Material Needed.

Loctite Thread Locking Compound
Grease, Anti-scuffing
SAE 20W Multi-use Oil

4-5 MAINTENANCE-FIELD AND BASE REPAIRS.

4-5.1 Stripping and Assembly Instructions.

4-5.1.1 *Antenna Clamp.*

a. Remove the three socket-head screws. Remove the clamping block, then the pin and nut from the clamping screw. Remove the clamping screw.

b. Assemble in the reverse order. Apply one drop of Loctite thread locking compound to the thread of each screw.

4-5.1.2 *Section Clamps.*

Stripping, proceed as follows:

a. Remove the two M5 socket-head screws which fix the right-hand clamp half to the collar. Retain the tubular spacer from the hole in the left-hand clamp half and remove the clamp assembly.

b. Unscrew the M5 stiffnut and remove it.

c. Remove the disc spacer followed by the ten disc springs and the plain washer.

d. Carefully examine the 4mm diameter pin which secures the handle to the left-hand clamp half. Identify which end of the pin has the straight knurl. Remove the pin by tapping the other end using a pin punch. Do not punch the knurled end of the pin through the assembly as this will cause damage.

e. Withdraw the handle assembly. Press out the 3mm diameter pin (this is not a tight fit) and separate the handle, connecting rod, and plastic disc.

Assembly, proceed as follows:

a. Apply grease, anti-scuffing, to the parts disassembled in operations c and d. Apply the grease sparingly and wipe off any surplus.

b. Insert the plastic disc into the eye of the connecting rod. The disc is symmetrical. Insert the combination into the handle and fit the 3mm diameter pin to retain the assembly.

c. Insert the handle assembly into the left-hand clamp half and fit the 4mm diameter pin to retain the assembly. Press the pin in until the knurled end is flush with the outer surface of the clamp. Ensure that the pin is driven with the parallel portion entering first.

d. Pass the threaded end of the connecting rod through the hole in the right-hand clamp half. Insert the plain washer. Assemble the ten disc springs in pairs. Insert the first pair of disc springs with the concave side inward. Insert three more pairs of disc springs with the concave sides alternately inward and outward. See Figure 4-1.

e. Assemble the disc spacer followed by the M5 stiffnut. Do not tighten the nut at this stage. Replace the nut completely if the nylon portion is worn.

f. Fit the clamp assembly around the mast section so that is rests upon the collar of the next lower section with the handle open and the counterfores uppermost. Insert the tubular spacer into the hole in the left-hand clamp half. Tighten the screws sufficiently to hold the assembly in place but do not tighten them fully yet.

g. With the clamping handle in the closed position, carefully tighten the M5 stiffnut so as to compress the disc springs. The object is to gradually compress the springs until they are just flattened. The application of much undue force beyond that needed to flatten the springs can result in damage. When this point is reached, slacken the stiffnut by 180 degrees (a half turn).

h. Tighten the two M5 socket-head screws. Release the handle and check that there is free movement between the clamp and the section around which it was clamped. Check that this section moves freely up and down. If there is any binding tendency, repeat the operation until the section moves with complete freedom.

4-5.1.3 *Piston Assemblies.* Six of the piston assemblies are similar, varying only in size and have a through hole which allows drainage and contributes to the functioning of the air damping system. The seventh piston in the smallest diameter tube has no through hole. Refer to figure 4-2.

Stripping, proceed as follows:

a. Release the clamp which is to be removed. Remove the two M5 socket-head screws which fix the right-hand clamp half to the collar. Remove the clamp assembly complete, retaining the tubular spacer from the hole in the left-hand clamp half.

b. Withdraw the tubular section. When the section passes its fully extended position, the plastic stop ring will be pushed out of its recess, allowing the section assembly to come out completely. The plastic stop ring may be left in place on the tube unless it is necessary to fit a new one.

c. Loosen the three socket-head screws in the piston assembly. In the case of the smallest section, do not loosen the screw in the center of the piston. This operation releases the lower clamping plate and the leather seal. It also releases the upper clamping plate and the sealing disc. Do not remove the screws completely.

d. Using a pin punch, tap the three radial pins inward where there is a space to receive them.

e. Withdraw the piston assembly complete. Disassemble the piston assembly by taking out the three screws and recover the three pins. In the case of the

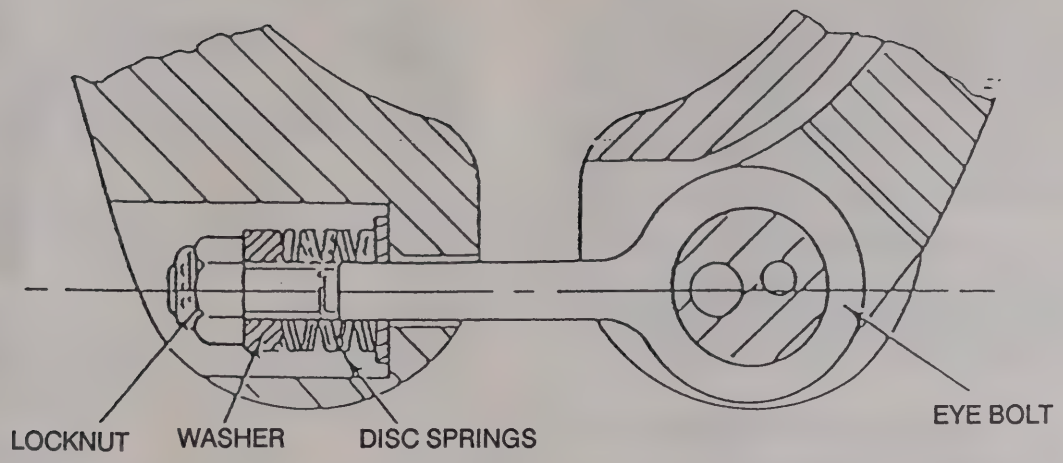


Figure 4-1. Arrangement of Disc Spring Assembly

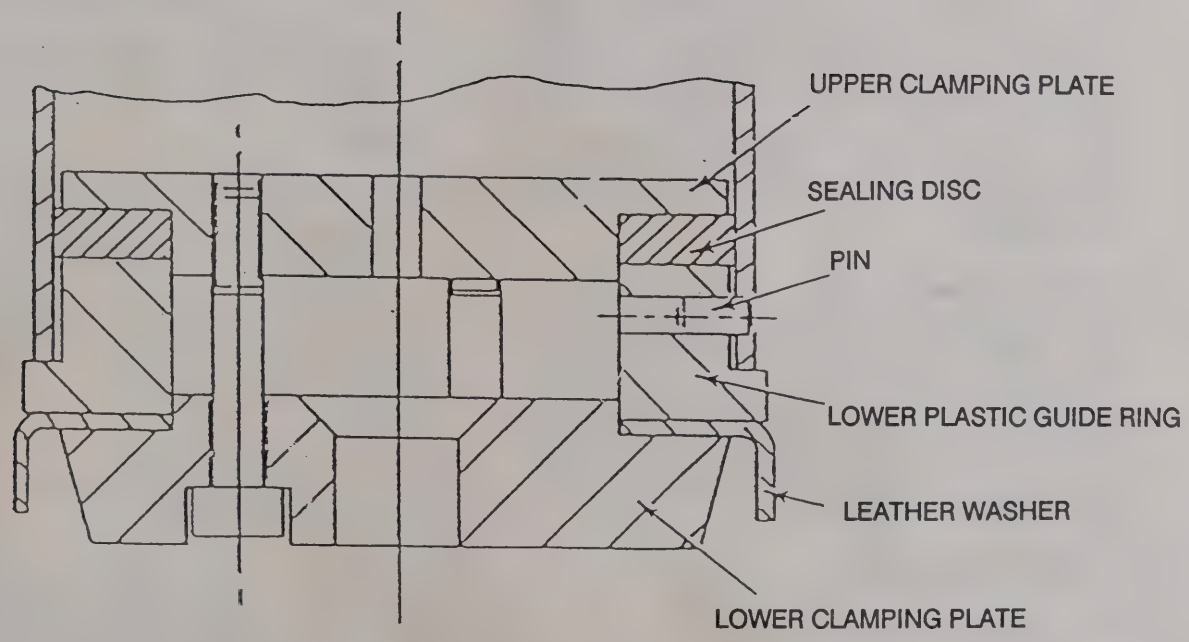


Figure 4-2. Arrangement of a Typical Piston Assembly

smallest piston, the three pins will be loose inside the section.

Assembly, proceed as follows:

a. Loosely assemble together the upper clamping plate, the sealing disc, the nylon guide ring, the leather washer, and the lower clamping plate. Apply one drop of Loctite thread locking compound to the thread of each screw. In the case of the smallest piston, tighten the center screw fully before fitting the piston assembly into the section.

b. Fit the pins and drive them in until they are flush with the outside of the tube. Ensure that the parts are all located concentrically and tighten the screws. The screws should be tightened gradually in sequence.

c. Fit the plastic stop ring onto the section assembly and position it above the fixed stop ring.

d. Dress the lip of the leather washer so that its contour is smooth and regular. A method of doing this is to pass a smooth round object, such as a pencil, round the lip with a gentle inward pressure. The leather should be soft and flexible. If it appears to be dry, it may be treated with SAE 20W Multi-use Oil.

e. Insert the section into the top of the next larger section. Take particular care to ensure that the leather is inserted without any part of the lip rolled back. A method of doing this is to roll a piece of thin Melinex sheet round the piston so that it projects beyond it. Insert the edge of the Melinex sheet into the opening and ease the piston in with a twisting motion; withdraw the Melinex sheet. Move the section into full engagement.

f. Fit the plastic stop ring into the recess provided for it. Re-fit the clamp assembly as described in para. 4-5.1.3, step (f). If the clamp assembly has not been disassembled, readjustment should be necessary. Alternatively, carry out the adjustment procedure detailed in para. 4-5.1.3, step (g). Finally, set the position of the clamp assembly as detailed in para. 4-5.1.3, steps (f), (g) and (h).

4-5.1.4 *Base Plug Assembly.*

Stripping, proceed as follows:

a. Using a 5mm diameter tommy-bar, remove the pivot from the mast base.

b. Slacken off the three M5 socket-head screws which were revealed by removal of the pivot. These screws should not be removed completely but only undone until they are slack. This releases the rubber sealing washer.

c. Remove the three M5 hexagon-head screws and associated plain washers. Remove the base plug assembly complete. This is most easily done if the pivot is re-inserted into the base for use as a handle.

d. Unscrew the three M5 socket-head screws and remove the sealing plate and sealing washer.

e. Using a tubular box spanner, remove the M6 stiffnut from the base. This will come out complete with the restrictor screw. If necessary, the restrictor screw may be removed from the stiffnut.

Alternatively, the combination may subsequently be replaced without the need for readjustment.

Assembly, proceed as follows:

a. Engage the restrictor screw in the M6 stiffnut. Insert the screw and nut combination into the mast base.

b. Fit the sealing washer and the sealing plate on top of the base, and retain in position by the three M5 socket-head screws. Apply one drop of Loctite thread locking compound to the thread of each screw before insertion. Leave the screws slack at this time.

c. Insert the base plug assembly into the bottom tubular section orientating it so that the exhaust hole is visible through the outer tube. Retain the base plug assembly in position using the three M5 hexagon-head screws and plain washers. Apply one drop of Loctite thread locking compound to the thread of each screw before insertion. Tighten the screws.

d. Expand the sealing washer by tightening the three M5 socket-head screws.

e. Adjust the pneumatic damping of the mast as follows. Erect the mast using the ground plate and pins and the erecting guys and stakes. First make sure that all the mast sections are in the fully closed position and the clamps are closed. Release the largest clamp and raise the largest moving section to the

full extent and close the clamp. (The smaller sections remain in the closed position). Allow a few seconds for the internal air pressures to equalize.

Now, release the clamp and measure the time taken for the mast to close fully. This time should be:

15 meter	Mast Type PM457	15-18 secs.

If the descent time is different, adjust the restrictor accordingly. Unlock the M6 stiffnut in the mast base using a tubular box spanner. Using a hexagon key, turn the restrictor screw clockwise to increase the time (and vice versa) and then lock the stiffnut. Repeat the procedure until the adjustment is correct.

f. Ensure that the M5 emergency bleed screw is screwed in fully and is not allowing air to leak.

4-5.1.5 *Stay Plates.*

Stripping, proceed as follows:

a. Disassemble the appropriate section as detailed in para. 4-5.1.3, steps (a) and (b).

b. Using circlip pliers, remove the circlip followed by the stay plate.

Assembly, proceed as follows:

a. Fit the stay plate in position and retain it with the circlip.

b. Complete the assembly of the mast following the procedure detailed in para. 4-5.1.3, steps (i), (j) and (k).

4-5.1.6 *Spirit Level Vial.*

Stripping, proceed as follows:

a. Using a pin punch, remove the 3/32-inch diameter pin.

b. Take out the following items: one 5/8-inch diameter plain washer, rubber moulding, and spirit level vial.

Assembly, proceed as follows:

a. Make sure that the mounting hole is free from dirt and burrs. Rectify if necessary.

b. Fit the spirit level vial ensuring that it is correctly sealed followed by the rubber moulding and the plain washer and retain them in position with the pin.

4-5.2 General Maintenance of Mast.

a. Before reassembly, ensure that all component parts of the mast are dry and free from dirt. Accumulations of dirt and grit may be washed away with clean water.

b. Check that the airways through the pistons are not obstructed.

c. Check all moving parts for wear. Replace where necessary.

d. Check all the stays and the haylard for fraying. Replace where necessary.

e. Check that the drain hole at the base of the mast is clear.

CHAPTER 5. ILLUSTRATED PARTS BREAKDOWN

5-1 **INTRODUCTION.** This Illustrated Parts Breakdown (IPB) illustrates all replaceable assemblies, subassemblies and components of the VH-830 TM/2 Antenna. This chapter is divided into two sections as follows:

I. Introduction
II. Maintenance Parts List

SECTION I. INTRODUCTION

5-2 **GENERAL.** This section includes a manufacturers code list and an explanation of how to use the parts list.

5-2.1 Abbreviations. All abbreviations used in this illustrated parts breakdown (IPB) are as follows:

List of Abbreviations

AP	Attaching Parts
AR	As Required
ASSY	Assembly
AUX	Auxiliary
DB	Decibels
DWG	Drawing
FSCM	Federal Supply Code for Manufacturers
FT, ft	Foot or Feet
GALV	Galvanized
GND	Ground
HDW	Hardware
HF	High Frequency
HS	High Strength
LBS, lbs	Pounds
LH	Left Hand
MPL	Maintenance Parts List
No	Number
PARA	Paragraph
REF	Reference
RH	Right Hand
SMR	Source Maintenance & Recoverability
SST	Stainless Steel
UTL	Utilities
VSWR	Voltage Standing Wave Ratio
XMSN	Transmission

5-5.2 Use of Illustrated Parts Breakdown. The following steps provide a simple procedure for obtaining all desired information in a systematic manner.

5-2.2.1 Part Number Not Known.

a. Determine the function and application of part required.

b. Turn to the list of illustrations and select the appropriate title.

c. If the list of illustrations is used, note the corresponding page number of the illustration.

d. Turn to the paragraph determined in step c and locate the figure number referenced within the text.

e. Turn to the illustration determined in step c and/or d and locate the part and index number of the subject part.

f. Turn to Section II, Maintenance Parts List and find the part number corresponding to the index number determined in step e. The index numbers in the Maintenance Parts List are listed in numerical sequence.

SECTION II. MAINTENANCE PARTS LIST

5-3 **GENERAL.** The Maintenance Parts List (MPL) contains a breakdown of the assemblies and parts contained in the antenna which can be disassembled, repaired, manufactured, reinstalled, replaced and reassembled.

5-4 **FORMAT.** The Maintenance Parts List is arranged as described below.

5-4.1 Figure and Index Number Column. This column shows the figure and index number of each item. The figure number appears only beside the first index number of each page. When a group of parts is used at a specific location for attachment purposes, only one is necessary to completely illustrate a particular assembly; the applicable sheet number follows the figure number in the parts list. For example, 7-6/2-81 means that reference is to be made to index number 81 on sheet 2 of figure 7-6 to find the illustration of the part.

5-4.2 Part Number Column. This column contains the design activities part number.

5-4.3 FSCM Code Column. This column contains the manufacturer's code identification number.

5-4.4 Description Column. This column contains the nomenclature for each item.

5-4.5 Indentation. The description of items listed are indented to indicate relationship as shown below.

(EXAMPLE)

1 2 3 4 5 6 7 DESCRIPTION

End Item Component, Major Assembly
. Detail parts for end item, component, major assembly
. Assembly
. Attaching parts for assembly (AP)
. . Detail parts for assembly
. . Subassemblies
. . Attaching parts for subassembly
. . Detail parts for subassemblies
. . . Sub-subassemblies
. . . . Detail parts for sub-subassemblies

5-4.6 Units Per Assembly Column. This column shows the following:

a. Quantity required for each detail part in an assembly.

b. Quantity required for each assembly in the next higher assembly.

c. Quantity required for each attaching part to attach one unit or one assembly.

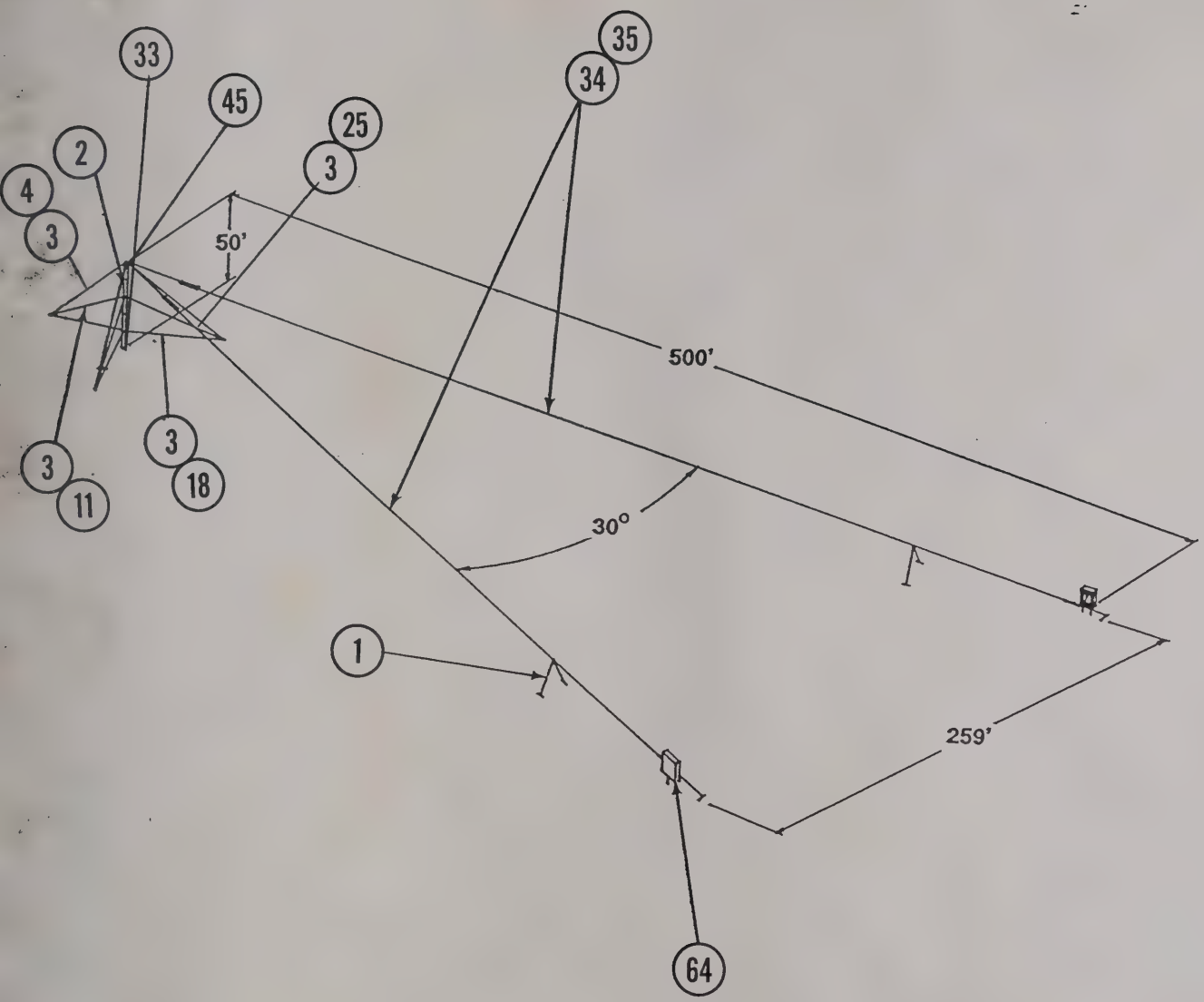


Figure 5-1. VH-830 Antenna (Sheet 1 of 6)

Figure 5-1. VH-830 Antenna (Sheet 2 of 6) Deleted

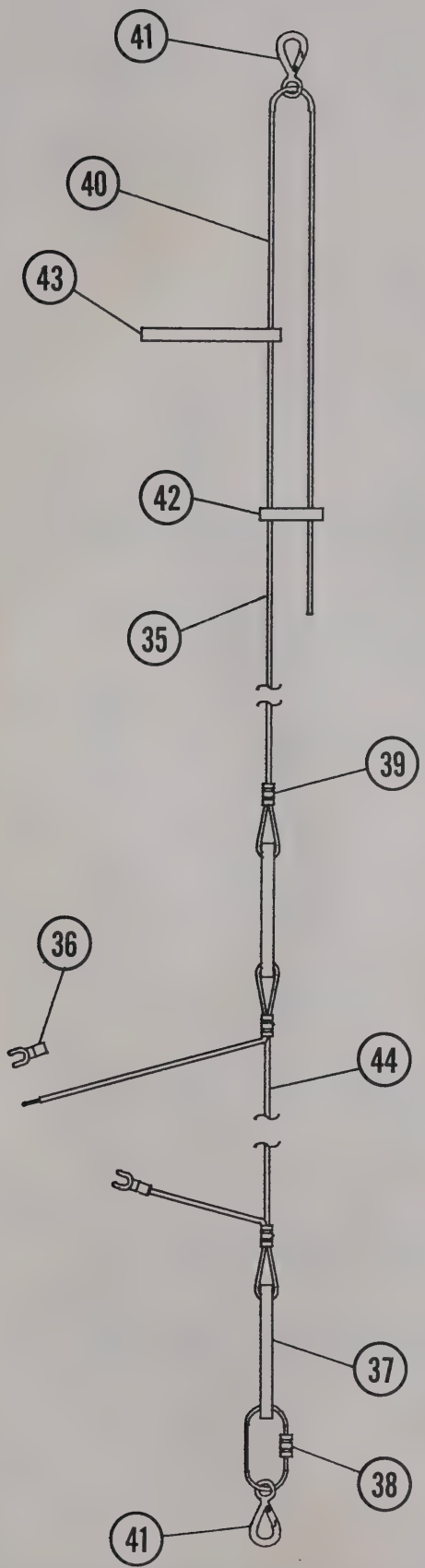


Figure 5-1. VH-830 Antenna (Sheet 3 of 6)

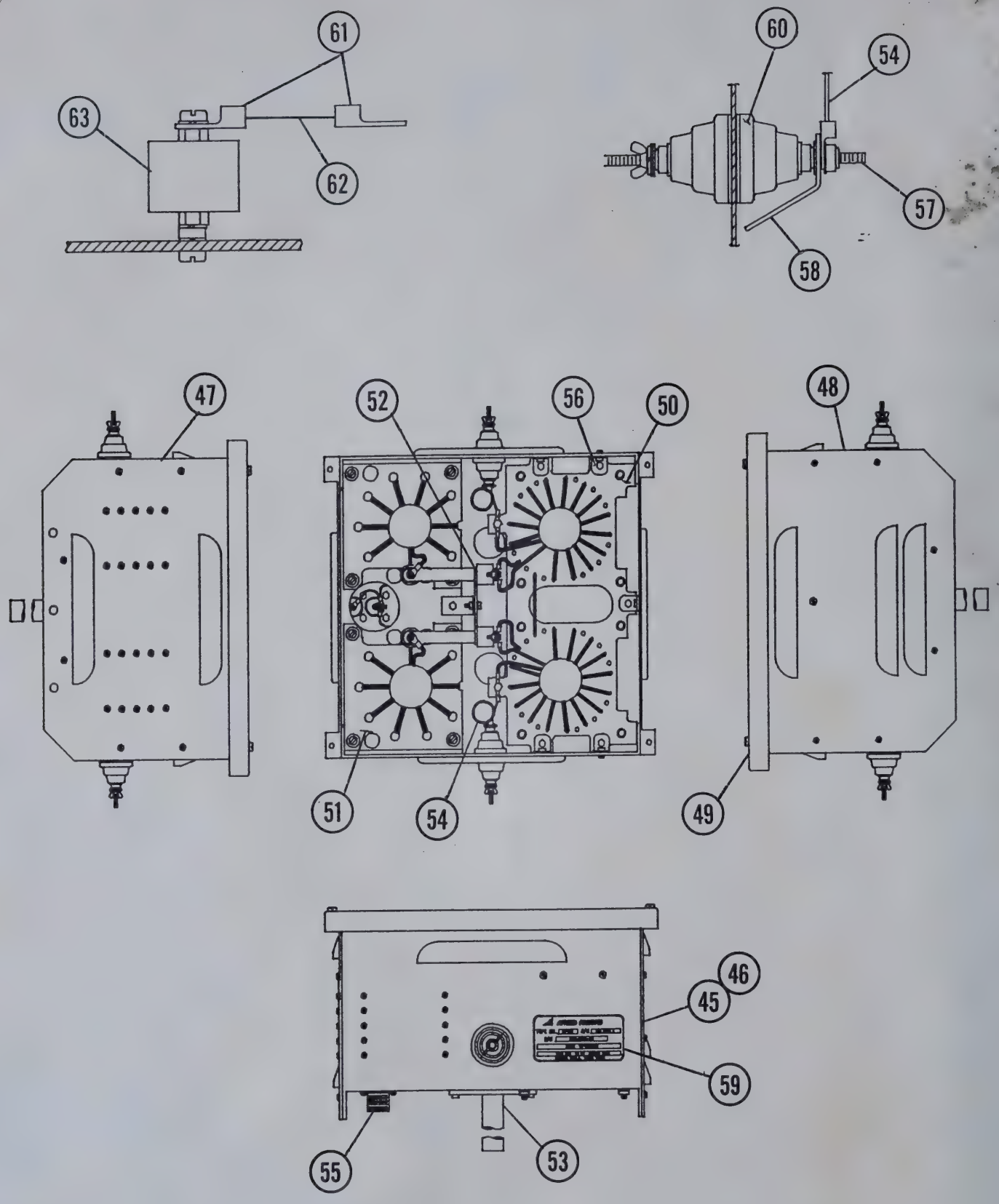


Figure 5-1. VH-830 Antenna (Sheet 4 of 6)

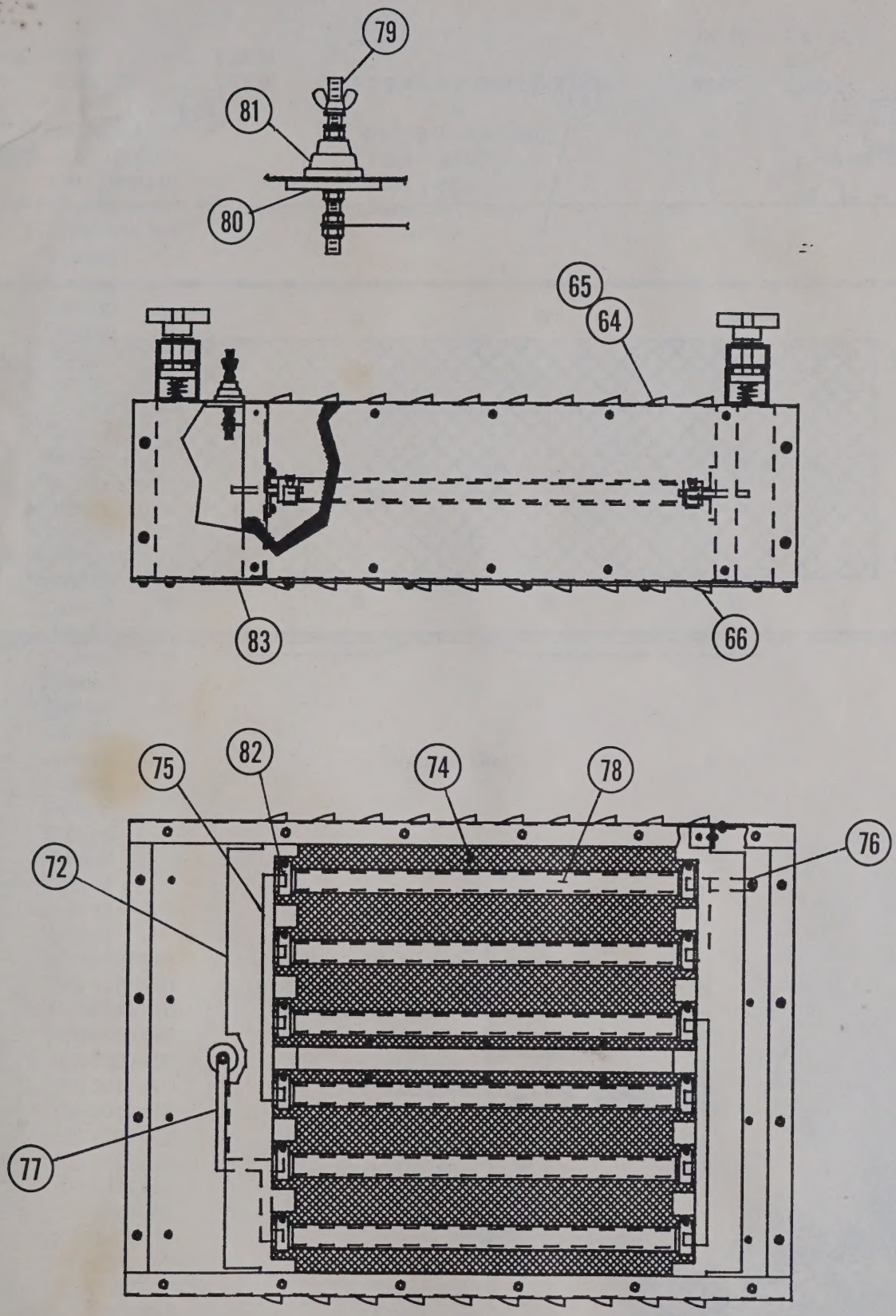
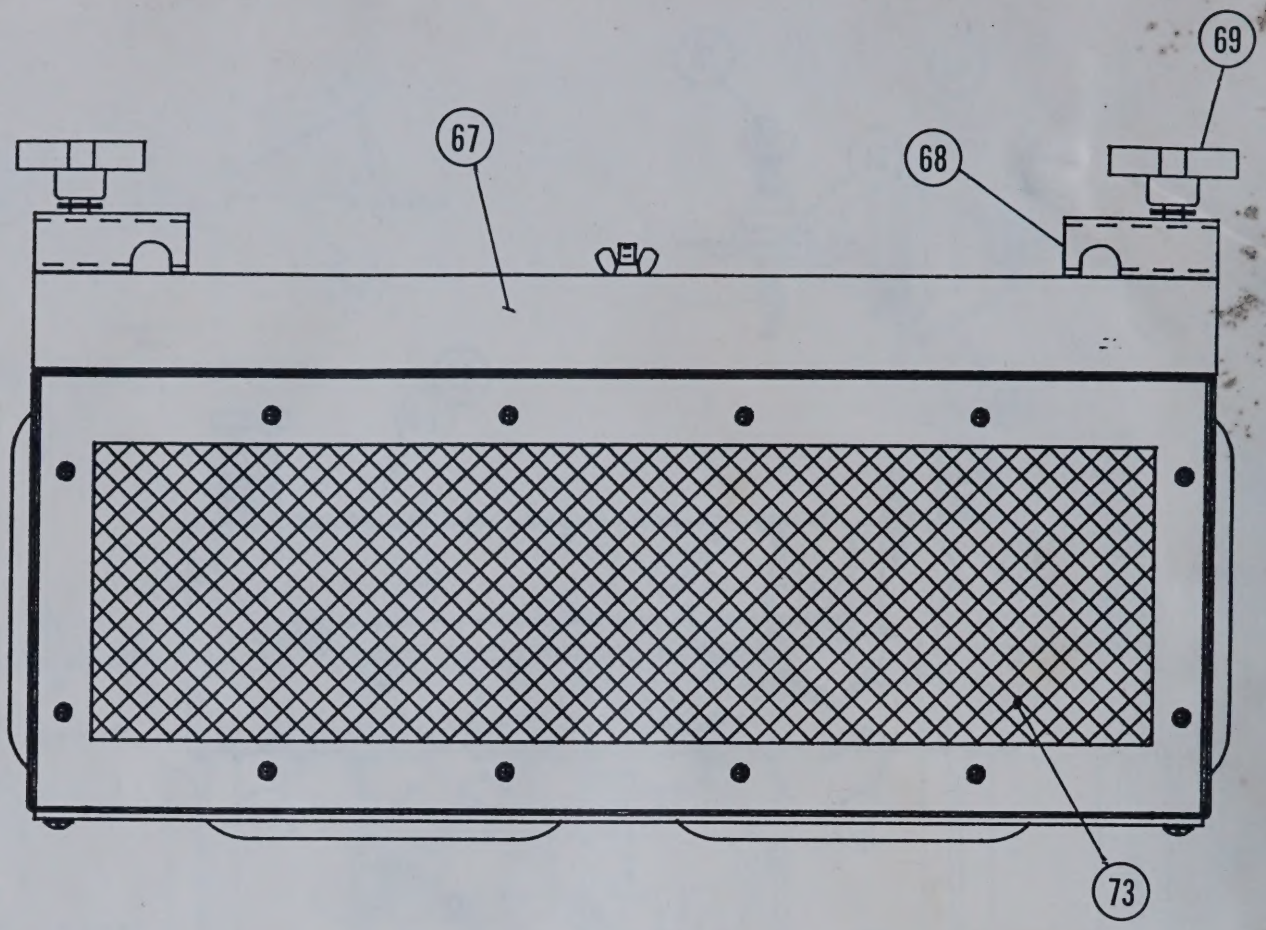


Figure 5-1. VH-830 Antenna (Sheet 5 of 6)



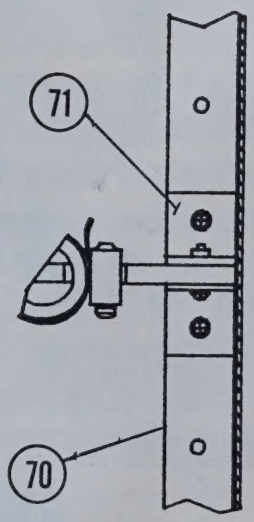


Figure 5-1. VH-830 Antenna (Sheet 6 of 6)

FIGURE AND INDEX NUMBER	PART NUMBER	FSCM CODE	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USABLE ON CODE	SMR
5-1	1500-0267-201		VH-830 System Items	1		
1-1	0003-0428-201		. Pole Assembly	2		
1-2	1000-1007-201		. Mast	1		
1-3	1000-1279-201		. Accessory Items	1		
1-4	0003-0419-301		. . Top Guy	2		
2-5	Deleted					
2-6	Deleted					
2-7	Deleted					
2-8	Deleted					
2-9	Deleted					
2-10	Deleted					
1-11	0003-0419-302		. . Middle Guy	3		
2-12	Deleted					
2-13	Deleted					
2-14	Deleted					
2-15	Deleted					
2-16	Deleted					
2-17	Deleted					
2-18	0003-0419-303		. . Lower Guy	3		
2-19	Deleted					
2-20	Deleted					
2-21	Deleted					
2-22	Deleted					
2-23	Deleted					
2-24	Deleted					
1-25	0003-0613-201		. . Top Back Guy	3		
2-26	Deleted					
2-27	Deleted					
2-28	Deleted					
2-29	Deleted					
2-30	Deleted					
2-31	Deleted					
2-32	Deleted					
1-33	0003-0507-301		. . Base Plate Assembly	1		
1-34	1000-1176-201		. Antenna Items	1		
3-35	0003-2444-303		. . Element Assembly	1		
3-36	8000-0360-097		. . . Terminal	1		
3-37	0002-8800-201		. . . Insulator	2		
3-38	2350-3015-003		. . . Compression Sleeve, 1/8 Al	3		
3-39	2350-3015-005		. . . Sleeve, Oval, 3/16 Dia.	1		
3-40	2630-1036-002		. . . Rope, Twisted 3/16 Dia.	8'		
3-41	2350-5266-001		. . . Snap Hook	2		
3-42	0003-0096-201		. . . Guy Aduster	1		
3-43	0002-3007-202		. . . Winder Board	1		
3-44	2630-0347-004		. . . Cable, 3/32 Dia., 7 x 19 Galv,	508'		
1-45	1000-1177-401		. Balun Items SM207	1		
4-46	0003-0568-401		. . Enclosure, Base	1		
4-47	0003-1120-301		. . End, Enclosure	1		
4-48	0003-1120-302		. . End, Enclosure	1		
4-49	0003-1121-301		. . Lid	1		

FIGURE AND INDEX NUMBER	PART NUMBER	FSCM CODE	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USABLE ON CODE	SMR
4-50	0003-2205-401		. . Winding Assembly	1		
4-51	0003-2208-401		. . Winding Assembly	1		
4-52	0003-2210-301		. . Capacitor Assembly	1		
4-53	0003-0571-201		. . Adapter Assembly	1		
4-54	0003-0585-201		. . Coil Assembly	2		
4-55	0003-2209-201		. . Connector Assembly	1		
4-56	0003-1148-201		. . Transformer Angle	5		
4-57	0002-8813-206		. . Stud	2		
4-58	0002-3602-201		. . Tab, Spark Gap	2		
4-59	0080-0147-201		. . Nameplate	1		
4-60	6300-0083-001		. . Insulator, Feed-thru, 1/4 Stud	4		
4-61	8000-0339-068		. . Terminal, Nonins, Comp Type, #16 AWG, #6 Stud	6		
4-62	4060-0198-009		. . Wire, Hook-up, Type EE, #16 AWG,	1 1/4"		
4-63	4300-0046-001		. . Capacitor, 25 pf	1		
1-64	1000-1431-401		. Termination Items	2		
5-65	0003-3147-401		. . Wraparound, Enclosure	1		
5-66	0003-3150-401		. . Cover, Enclosure	1		
6-67	0003-3078-401		. . End, Enclosure	2		
6-68	0003-3152-201		. . Channel, Mounting	2		
6-69	0003-4196-201		. . Clamp Assembly	4		
6-70	0003-4155-201		. . Support, Bracket	4		
6-71	0003-3077-201		. . Angle, Support	8		
5-72	0003-3076-201		. . Plate, Support	2		
6-73	0003-3151-201		. . Screen, End	2		
5-74	0003-3151-202		. . Screen, Enclosure	6		
5-75	0003-3154-201		. . Strap, Jumper	1		
5-76	0003-3156-301		. . Strap, Ground	1		
5-77	0003-3157-301		. . Strap, Input	1		
5-78	7200-0001-001		. . Resistor, 300 Ohm	6		
5-79	0002-2081-203		. . Stud	1		
5-80	0002-8786-201		. . Plate, Insulator	1		
5-81	6300-0083-201		. . Insulator	1		
5-82	MS35842-11		. . Clamp, Hose	12		
5-83	0080-0146-201		. . Nameplate	1		